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THREE ESSAYS ON FOOD SAFETY REGULATIONS AND INTERNATIONAL TRADE OF AGRICULTURAL PRODUCTS

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THREE ESSAYS ON FOOD SAFETY REGULATIONS AND INTERNATIONAL TRADE OF AGRICULTURAL PRODUCTS

DISSERTATION

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the College of Agriculture, Food and Environment at the University of Kentucky

By

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Lexington, Kentucky

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Lexington, Kentucky

2017

ABSTRACT OF DISSERTATION

THREE ESSAYS ON FOOD SAFETY REGULATIONS AND INTERNATIONAL TRADE OF AGRICULTURAL PRODUCTS

This dissertation investigates food safety regulations and international trade of agricultural products dividing into three aspects: the signalling effect from U.S. strict food safety regulations on U.S. vegetable exports, political determinants of sanitary and photosanitary non-tariff barriers, and the impact of trade barriers on employment in developing countries. In chapter 2, we investigate the impact of high U.S. maximum residue limit (MRL) standards on U.S vegetable exports to 102 countries utilizing the hierarchical model. MRL, which is one of non-tariff barriers with respect to food safety, is applied to home and foreign countries at the same time. Thus, firms in countries with higher food safety standards are expected to have a competitive advantage from the 'signalling effect'. The results show that high MRL standards in the U.S. have a positive impact on U.S. vegetable exports, indicating the 'signalling effect' from the strict U.S. domestic MRL standards. The results provide policy makers with insights into how strict food safety regulations of the home country can be considered as a catalyst for increasing competitiveness in international markets.

In chapter 3, we examine the political determinants of SPS notifications using a nonlinear threshold model with possible threshold variables (GDP per capita and tariff rate). This article finds no threshold values in both variables of GDP per capita and tariff rate. Our results also show that GDP per capita has a positive relationship with SPS notifications that are one of proxy variables for food quality. That implies the importance of quality competition in agriculture and food sectors. Our finding also represents no significant effect of tariff on SPS notifications. This indicates that a law of constant protection, presenting an inverse relationship between tariff and non-tariff barriers, is not satisfied in the agricultural and food sectors.

In chapter 4, we investigate the impact of tariff and SPS barriers on food manufacturers' skilled and unskilled employment in developing countries utilizing a structural equation model. Results show that both tariff and SPS barriers have a positive effect on unskilled labor employment in developing countries, while trade barriers are not associated with skilled labor employment. This implies that Hecksher-Ohlin theory, presenting labor abundant countries have a comparative advantage in labor-intensive industries such as food, explains well our results since developing countries are abundant in low-skilled labor. We also find that the age of food firm in developing countries is positively related to skilled employment; however, no relationship with unskilled employment. This implies that older food firms change their production process from labor intensive to capital or machine intensive.

KEYWORDS: Food safety, Employment, Maximum residue limits, Political economy, Sanitary and photosanitary

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November 29, 2017

THREE ESSAYS ON FOOD SAFETY REGULATIONS AND INTERNATIONAL TRADE OF AGRICULTURAL PRODUCTS

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Chapter One

Introduction and Overview

According to the World Health Organization (WHO), global food safety concerns have arisen due to several hazards such as microbiological hazards and chemical food contaminants. As the globalization trend has expanded, the risk of food safety problems has also increased because of increased trade of agricultural products. To address the international food safety concerns, the Codex Alimentarius international food standard was introduced by the WHO and Food and Agriculture Organization of the United Nations (FAO). Furthermore, the World Trade Organization (WTO) established the Sanitary and Photosanitary (SPS) agreement on January 1995, which sets food safety and animal and plant health rules and regulations.

These food safety regulations play a role as non-tariff barriers due to the impeding role of high food safety regulations on trade of agricultural products. Some political economists such as Bhagwati (1989) argue that many countries set up high non-tariff barriers such as food safety regulations to protect farmers from world-wide globalization pressures. Other political economists such as Ray (1981) find that countries with high tariff barriers have a tendency to have high non-tariff barriers. In other words, political economists have debated on the relationship between tariff and non-tariff barriers. Therefore, investigating the relationship between food safety regulations (one of non-tariff barriers) and tariff barrier is expected to contribute and fill a gap in previous political economic studies.

Contrary to non-tariff barriers such as quotas, food safety regulations such as MRL are applied to domestic and foreign agricultural products at the same time. Thus, food safety regulations are expected to have a different effect on agri-food sectors compared to other non-tariff barriers. Non-tariff barriers such as quotas only have a protection role, while food safety regulations have both characteristics of impeding and promoting trade. The promoting role of food safety regulations is stem from experience or signalling effect. If exporting firms experience strict food safety regulations in their home countries, then they might export easily due to the easy adaption to foreign food safety criteria or gain a competitive advantage from strict food safety regulations.

Trade liberalization is closely related to technology transfer, innovation, competition, and specialization. These factors are positively associated with productivity that is negatively related to employment. That implies the possible relationship between trade and employment. Thus, food safety regulations, one of non-tariff barriers in agricultural and food sectors, also are expected to have a relationship with employment. Large share of tariff barriers have eliminated or reduced by trade agreements or WTO regime, while food safety regulations have increased due to human health or protection purpose. In other words, the importance of food safety regulations on employment in agricultural and food sectors has increased.

This dissertation focuses on food safety regulations and international trade of agricultural products by investigating the three questions outlined above. Three research questions are investigated by each of following three essays. The first essay (Chapter 2), entitled: "*The 'Signalling Effect' and the Impact of High Maximum Residue Limit Standards on the U.S. Vegetable Exports*," investigates the probability that a home country's strict food safety regulations may improve a home country's competitiveness by the 'signalling effect'.

The second essay (Chapter 3), entitled: "*Political Determinants of Sanitary and Photosanitary Notifications: Testing the Law of Constant Protection and Food Safety Demand*," tests the law of constant protection, which is an inverse relationship between trade and non-tariff barriers. Furthermore, the second essay investigates the determinants of SPS notifications using a nonlinear threshold model with GDP per capita and tariff rate variables by focusing on political factors

The third essay (Chapter 4), entitled: "*Trade Barrier Effects of Sanitary and Photosanitary on Skilled and Unskilled Workers in Food Manufacturing Firms*," investigates food safety related non-tariff barrier reduction effects on unemployment, differentiating between skilled and unskilled workers. Utilizing the structural equation model, this chapter divides the impact of trade barriers on employment into direct effects (technology effect) and indirect effects (production quantity change caused by trade barriers).

Chapter 5 summarizes the findings and implications of each chapter of this dissertation. In addition, future related studies are discussed.

Chapter Two

The 'Signalling Effect' and the Impact of High Maximum Residue Limit Standards on U.S. Vegetable Exports

2.1 Introduction

Food safety standards have been on the rise as world income has increased for the last few decades, partly due to the fact that high income consumers are more sensitive to health and safety concerns. Most governments set Sanitary and Phytosanitary (SPS) standards such as Maximum Residue Limits (MRLs) in order to protect consumers. As governments have implemented more and stricter food safety regulations, trade disputes have increased among the countries involved. A total of 17,373 SPS notifications were submitted to the WTO during 1995 to 2014 (WTO Integrated Trade Intelligence Portal). RTAs have also increased during the last few decades, which in turn, have raised the call for more domestic market protection. RTAs have an important role in the reduction of tariff barriers and quantitative restrictions among countries. WTO reported receiving 612 notifications of RTAs through 4/7/2015 (WTO Integrated Trade Intelligence Portal).

Some studies have argued that non-tariff barriers (like SPS regulations) have increased because governments want to protect their producers (Götz et al., 2010). Even when a government's purpose for an SPS standard is for food safety concerns and consumer protection, political economists have raised concerns about the protectionist impacts of SPS and other technical barriers (Götz et al., 2010; Kastner and Pawsey, 2002; Peterson and Orden, 2008). Hence, the importance of understanding the impacts of non-tariff barriers (such as SPS standards) has increased for agricultural trade.

There are different views concerning the effects of SPS standards on competitiveness. Henson and Jaffee (2008) have shown that tighter standards can be a source of competitive advantage for certain countries. One possible explanation for this is the signalling the quality of agricultural products. Falvey (1989) argue that the countries of regulations may play a crucial role as signalling the information for product quality. Thus, food manufacturers in the country with high food safety standards signal that their products have high quality. In this sense, higher SPS standards in the home country might be a source of competitive advantage. Hence, domestic SPS standards might have a positive impact on exports due to the signalling effect, and therefore, increase competitiveness of the firms facing tough food safety regulations. To be more specific, on one hand, SPS standards in the home country could have a positive impact on the exports of home country firms because of the signalling effect. On the other hand, SPS standards in the foreign country could have a negative effect on exports since SPS of foreign countries are considered as hurdles to overcome for exporters.

In this study, we investigate the impact of the signalling effect on firms facing high SPS in the home country since SPS regulations applied to domestic and foreign agricultural products, are the most dominant non-tariff barriers facing agricultural industries. Among the SPS safety regulations, we focus on the MRL standards due to the fact that MRL has a record of detailed dataset related to pesticides and pesticides residue levels that are very important factors raising food safety concerns. This paper chooses the U.S. for this study because it is one of the major agricultural exporting countries and the MRL database is constructed in a way that is consistent with the U.S. data. We use the Harmonized System (HS) 4-digit vegetable export data since the MRL regulates the pesticide levels that are often used in vegetable production.[1] This research investigates whether high MRL standards in the home country (U.S.) expedites its vegetable exports, using the MRL based protectionism index suggested by Li and Beghin (2014).[2]

2.2 Literature Review

The key issue in analyzing non-tariff barriers is the measurement problem. A tariff barrier is easily captured since it has a numerical value for every product. However, non-tariff barriers are hard to measure numerically. For this reason, empirical studies try to quantify non-tariff barriers in several ways. Nogues et al. (1986) measured NTMs by the concept of converge ratios ($= \frac{\sum import\ values\ on\ NTMs}{\sum all\ import\ values}$). In other words, they tried to quantify NTMs as a similar concept and format with a tariff. Bradford (2001) calculated the markup price from NTMs using OECD data on specific product prices across countries. The markup price from NTMs indicates price increases due to NTMs. Andriamananjara et al. (2004) tried to measure the percentage change in price of 160 products and services in 79 countries due to NTMs. To sum up, these papers calculate NTMs by price or value changes.

Some studies have captured NTM effects on trade by quantity concepts (Harrigan, 1993; Leamer, 1990). For example, Harrigan (1993) measured NTMs' effect on import

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[1] This paper uses the HS chapters 6 to 14 (Section 2. Vegetable Products).

[2] We calculate the MRL protectionism index by modifying the one suggested by Li and Beghin (2014):

$$MRL\ protectionism\ index = \frac{1}{T_{(k)}}\left(\sum_{t_{(k)}}^{T_{(k)}} \exp\left(\frac{M_{avg,kt_{(k)}} - M_{jkt_{(k)}}}{M_{avg,kt_{(k)}}}\right)\right)$$

where $M_{jkt_{(k)}}$ is the maximum residue level of importer j, for good k, and harmful substance $t_{(k)}$. $M_{avg,kt_{(k)}}$ is the average maximum residue level for the same good with a harmful substance.

quantity using a monopolistic competition model. Mayer and Zignago (2005) captured NTMs' effect as residuals in the gravity equation model. Some studies have also derived other methods to calculate trade restrictiveness indices by the NTMs. Looi Kee et al. (2009) estimated trade restrictiveness indices using the concept of NTBs ad-valorem equivalents compared to tariffs. Yue et al. (2006) measured the tariff equivalent of Japanese Technical Barriers to Trade (TBT) regulations.

The NTMs on agricultural products heavily depend on food safety standards (Disdier and Tongeren, 2010). General Agreement on Tariffs and Trade (GATT) and WTO have reduced NTBs such as quotas (Sanders et al., 1996). However, the importance of food safety has increased due to increased GDP and food risks. For this reason, many studies on NTBs in the agricultural sector focus on the effects of food safety standards. Disdier et al. (2008) used dummy variables to indicate the existence of NTMs at the 6 digit HS level. Xiong and Beghin (2011) used the numerical values of MRLs for groundnuts to analyze the effect of aflatoxin on African exports.[3] However, these single disaggregated NTMs may have a problem with subjective selection bias (Li and Beghin, 2014).[4] Even if there is no selection bias, a single NTM may not represent all relevant NTMs for the product (Li and Beghin, 2014).

To overcome this subjective selection bias problem, Rau et al. (2010) defined the heterogeneity index of trade (HIT). The HIT aggregates diverse regulations such as ordered, binary, or quantitative NTMs (Rau et al., 2010). However, the HIT does not give

[3] Aflatoxin is a poisonous, cancer-causing chemical that is produced by particular mould. Its maximum residues are regulated in MRLs.

[4] The subjective selection bias comes from picking one NTM as representative of all NTMs. For this reason, just picking the aflatoxin tolerance and estimating the effect of aflatoxin may cause bias

information about relative strictness since the HIT is non-directional (Li and Beghin, 2014). This index is calculated by bilateral dissimilarity; so that one does not know the relative rigidity based on their index (Li and Beghin, 2014). To know the directional rigorousness, the index must be calculated by the concept of relative rigidity instead of dissimilarity (Li and Beghin, 2014). In this sense, the HIT index is non-directional. To overcome this non-directional problem, Winchester, et al. (2012) suggested a directional HIT (DHIT).

The DHIT captures the rigidity rather than dissimilarity between two countries using MRL data for agricultural products (Li and Beghin, 2014). Even though Winchester, et al. (2012) tried to capture rigidity using the DITT index, this index still has a problem in gauging the relative strictness or laxness of policies. For example, a 5 ppm difference from 100 ppm is identical to a 5 ppm difference from 20 ppm with the DITT index (Li and Beghin, 2014). However, this 5 ppm difference could be more important from a base of 20 ppm than a base of 100 ppm. To avoid these problems, Li and Beghin (2014) developed the MRL protectionism index. Their index is based on the science-based standards of international MRL. They defined the importer's MRL standard as strict if it is lower than the international MRL.

Another key area of studies for NTMs is their effect on trade. In the agricultural sector, most papers focus on food safety regulation effects among NTMs barriers. It is well known that SPS standards can impede trade in agricultural and food products (Jaffee, 1999; Thilmany and Barrett, 1997; Unnevehr, 2000). Thornsbury et al. (1997) found that 90% of NTM effects on U.S. agricultural exports is explained by the SPS. Henson and Loader (2001) argued that the SPS standard is the major factor for determining developing countries' agricultural exports to developed countries. Based on a survey, they determined that developed countries have a higher SPS standard than developing countries and that these higher standards in developed countries are the major barrier to developing countries' agricultural product exports to developed countries. Fontagné et al. (2005) showed that NTMs have a negative effect on fresh and processed food imports using the ad-valorem equivalents of NTMs and data at the 6-digit HS level. Disdier et al. (2008) also found that SPS and TBT measures have a negative effect on agricultural product trade using ad-valorem equivalents of the SPS and TBT regulations and OECD trade data.

Studies of NTMs' effect on trade mainly focus on their role in impeding trade. However, NTMs may have an expediting role in trade for individual firms or nations. This expediting role may exist for the agricultural sector rather than other sectors since NTMs in the agricultural sector are heavily dependent on food safety regulations. Contrary to normal NTMs, food safety regulations are relevant to all firms in the country – importers, exporters, and domestic producers. Most NTMs, such as quotas, are regulated by importing countries and are only relevant to exporting countries. However, food safety regulations imposed by importing countries are effective for importing and exporting countries. If exporting countries have strict NTMs for food safety reasons, then exporting countries may have a competitive advantage, which is based on the signalling effect. The signalling effect mechanism is that consumers perceive the agricultural products from high food safety regulations as high quality products. In addition, exporting firms save costs through their accumulated export experiences (Schmeiser, 2012). Lawless (2009) argued that experienced exporters have lower bureaucratic costs connected with exporting, marketing, and distribution. Some studies also emphasize spillover effects on exporting firms from learning (Cassey and Schmeiser, 2012; Koenig, 2009).

2.3 Background on Maximum Residue Limits

Veterinary drugs are used in animals to deal with disease, keeping herds healthy, encouraging growth, enhancing meat quality, and increasing carcass yields. Using veterinary drugs can leave residues in food, which is termed as veterinary drug residue.[5] Residue is defined as an outcome from drugs or pesticides applied to animals or plants to produce food (FAO, 2006). This definition contrasts residues from contaminants, which Di Caracalla (1997) defines as "any biological or chemical agent, foreign matter or other substances not intentionally added to food that may compromise food safety or suitability". Pesticide residue indicates the remaining pesticides in foods after the product is applied to a food crop (McNaught and Wilkinson, 1997).

MRLs are the maximum concentrations of pesticide and veterinary drug residues allowed, as regulated by national or regional legislation (FAO, 2006). MRLs also are adaptable to animal feeds since feeds affect the residue levels in meats. The Codex Alimentarius Commission (CAC) sets the international guideline of MRLs. To set up the international criteria for MRLs, the CAC held two committees -- the Codex Committee on Pesticide Residues (CCPR) and the Codex Committee on Residues of Veterinary Drugs in Foods (CCRVDF). These committees came up with international MRLs based on the advice of scientific experts and the recommendations of risk assessors such as the

[5] http://www.romerlabs.com/us/knowledge/veterinary-drug-residues/

Joint FAO/WHO Expert Meeting on Pesticide Residues (JMPR) and the Joint FAO/WHO Expert Committee on Food Additives (JECFA).

The CAC has held 38 sessions, the 38th session was in July 2015, and has made a database for pesticides of the Codex Maximum Residue Limits (CMRL) and Veterinary Drugs MRLs (VMRL).[6] CMRL contains five commodity categories of "Primary Animal Feed Commodities", "Primary Food Commodities of Animal Origin", "Primary Food Commodities of Plant Origin", "Processed Foods of Animal Origin", and "Processed Foods of Plant Origin". CMRL are defined for 196 pesticides and VMRL are defined for 74 drugs.

2.4 MRL Protectionism Indices

This paper uses the 4-digit level of HTS in matching data for vegetables (see table 2.1). This aggregation is beneficial for cross sectional econometric analysis with goods and countries (Li and Beghin, 2014). Using this aggregation method, we can suggest two aggregate scores for a country's average protectionist score by commodity and country in terms of SPS regulations. This paper modifies the MRL protectionism indices of Li and Beghin (2014). Their MRL protectionism indices are based on the science-based international MRL (Codex). If an importer's MRL is higher than the Codex level, then this importer is considered as an MRL-non-protectionist. The following index is the MRL protectionism index of Li and Beghin (2014):

[6] http://www.fao.org/fao-who-codexalimentarius/standards/pestres/en/

$$MRL\ protectionism\ index = \frac{1}{T_{(k)}}(\sum_{t_{(k)}}^{T_{(k)}} \exp(\frac{M_{intl,kt_{(k)}} - M_{jkt_{(k)}}}{M_{intl,kt_{(k)}}})) \qquad (1)$$

where, $M_{jkt_{(k)}}$ is the maximum residue level of importer j, for good k, and unsafe material $t_{(k)}$. $M_{intl,kt_{(k)}}$ is the international maximum residue level for the identical good and unsafe material.

This protectionism index has a problem when the Codex MRL is missing for a product or pesticide, or when there are multiple MRLs. Li and Beghin (2014) focused on measuring the MRL protectionism index by country and product. However, we focus on the HTS 4-digit level for vegetables, which leads to an aggregation problem for each vegetable criteria. So, we modify Li and Beghin (2014)'s index using the average MRL. The following index is the modified index used in this study:

$$Modified\ MRL\ protectionism\ index = \frac{1}{T_{(k)}}(\sum_{t_{(k)}}^{T_{(k)}} \exp(\frac{M_{avg,kt_{(k)}} - M_{jkt_{(k)}}}{M_{avg,kt_{(k)}}})) \qquad (2)$$

where, $M_{jkt_{(k)}}$ is the maximum residue level of importer j, for good k, and unsafe material $t_{(k)}$. $M_{avg,kt_{(k)}}$ is the world average maximum residue level for the identical good and unsafe material. The modified MRL protectionism index has a slightly different meaning from the original MRL protectionism index. The original MRL index increases if a country has strict residue limits compared to the Codex. The modified MRL protectionism index increases if a country has strict residue limits compared to the world average.

This modified MRL protectionism index has several useful properties which are similar with Li and Beghin (2014)'s index. First, this index is unit-free since it is calculated in relative terms (percent). Second, the exponential function represents increasing marginal difficulty in meeting strict pesticide criteria. Third, the index is calculated by subtracting the importer's MRL from the world average MRL. Fourth, this protectionism index has a lower and upper bound due to the fact that it is divided by the average world residue level. It is also monotonically non-decreasing in MRL protectionism for different countries (other things equal) since it is an exponential function.

2.5 Data Description

This paper uses the Global MRL database (https://www.globalmrl.com/) accessed online in December 2015. This database contains pesticide MRLs, which are used since this paper focuses on vegetable exports. The vegetable pesticide database covers 534 products, 294 pesticides, and 102 countries. Table 2.1 represents the number of pesticides which are included in the Global MRL database according to products (HS 2-digits level). The number of pesticides for the chapters 7 and 8, "Edible vegetables and certain roots and tubers" and "Edible fruit and nuts; peel of citrus fruit or melons", is 381. Thus, the pesticides for chapter 7 and 8 occupy 71% of those included in the Global MRL database.

This Global MRL database has detailed information; however, Li and Beghin (2014) point out two drawbacks. First, the MRL dataset defines only chemical lists which are available to U.S. farmers. In other words, foreign pesticides or chemicals exist in this database only if these pesticides or chemicals exist in the US. Thus, there is a possibility that foreign countries have a regulation for pesticides or chemicals which are not contained in the Global MRL dataset. However, this problem is minimized since the U.S. has comprehensive pesticides and chemicals (Li and Beghin, 2014). Furthermore, Li and Beghin (2014) tried to compare the United States Department of Agriculture (USDA) data and the Homologa of the United Kingdom Department for Environment, Food and Rural Affair data. According to their comparison, the USDA has longer lists compared to the Homologa. In this sense, they argued that the problem of pesticide restrictions is controllable.

Table 2.1 Vegetable Product Categories in the Pesticide Database (2015)

HTS Chapter for Vegetables	Counts
Chapter 6: Live trees and other plants; bulbs, roots and the like; cut flowers and ornamental foliage	26
Chapter 7: Edible vegetables and certain roots and tubers	187
Chapter 8: Edible fruit and nuts; peel of citrus fruit or melons	194
Chapter 9: Coffee, tea, maté and spices	38
Chapter 10: Cereals	15
Chapter 11: Products of the milling industry; malt; starches; inulin; wheat gluten	2
Chapter 12: Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruits; industrial or medicinal plants; straw and fodder	66
Chapter 13: Lac; gums, resins and other vegetable saps and extracts	5
Chapter 14: Vegetable plaiting materials; vegetable products not elsewhere specified or included	1
Total	534

The second problem is non-established residues in the MRLs. Some non-established MRLs exist in the international level (Codex) or the country level, so there are many missing values in the MRL database by country or Codex level. Even if the Global MRL database focuses on the US, the Global MRL has information of Codex and U.S. for pesticides. Thus, it is a reasonable assumption that both Codex and U.S. regulate most of pesticides in the world (Li and Beghin, 2014). Furthermore, it is hard to find banned pesticides sustained by other countries. However, there are probably missing data for some pesticides levels. The missing data problem has been reduced by USDA updating data in 2012 (Li and Beghin, 2014).

Table 2.2 Top and Bottom 10 Countries Based on the MRL Protectionism Index

Top 10 countries			Bottom 10 countries		
Countries	Protectionism Index	GDP per capita (2014)	Countries	Protectionism Index	GDP per capita (2014)
1. Taiwan	1.843		1. Japan	0.720	$36,194.4
2. Kazakhstan	1.676	$12,601.7	2. Bahrain	0.724	$24,855.2
3. Finland	1.572	$49,823.7	3. Qatar	0.724	$96,732.4
4. Denmark	1.571	$60,707.2	4. Oman	0.728	$19,309.6
5. Malta	1.571		5. Kuwait	0.729	$43,593.7
6. United Kingdom	1.571	$46,332.0	6. United States	0.733	$54,629.5
7. Greece	1.571	$21,498.4	7. Mexico	0.737	$10,325.6
8. Slovenia	1.571	$23,999.1	8. Honduras	0.787	$2,434.8
9. Czech Republic	1.570	$19,529.8	9. Dominican Republic	0.849	$6,163.6
10. Spain	1.570	$29,767.4	10. Hong Kong	0.895	$40,169.5
Average	1.609	$33,032.4	Average	0.763	$33,440.8

Table 2.2 shows the top (highest MRL index and protection) and bottom 10 countries based on the MRL protectionism index. The top and bottom 10 countries are not highly correlated with GDP per capita, which is also shown in the table. It seems that even if high income people are concerned about food safety issues, some high GDP countries do not have strict MRL regulations. Furthermore, some lower GDP countries still set high MRL regulations for the health of their people.

Table 2.3 Top and Bottom 10 Products Based on the MRL Protectionism Index

Top 10 products		
HS	detail	Index
0906	cinnamon and cinnamon-tree flowers	1.658
0908	nutmeg, mace and cardamoms	1.647
0905	vanilla beans	1.635
0909	seeds, anise, badian, fennel, coriander, cumin etc.	1.613
0601	bulbs, tubers etc., chicory plants & roots naosoi	1.455
1207	oil seeds & oleaginous fruits naosoi, broken or not	1.414
1204	flaxseed (linseed), whether or not broken	1.412
0705	lettuce and chicory, fresh or chilled	1.396
1211	plants etc. for pharmacy, perfume, insecticides etc.	1.381
0910	ginger, saffron, turmeric, thyme, bay leaves etc.	1.379

Bottom 10 products		
HS	detail	Index
0806	grapes, fresh or dried	1.132
1210	hop cones, fresh or dried, lupulin	1.135
0814	peel, citrus or melon, fresh, frzn, dried, provsl pres	1.154
0707	cucumbers and gherkins, fresh or chilled	1.156
0809	apricots, cherries, peaches, plums & sloes, fresh	1.158
0808	apples, pears and quinces, fresh	1.163
0805	citrus fruit, fresh or dried	1.167
1002	rye in the grain	1.172
0702	tomatoes, fresh or chilled	1.176
0901	coffee, coffee husks etc., substitutes with coffee	1.177

Table 2.3 represents the top and bottom 10 products based on the MRL protectionism index. Five products belonging to chapter 9, “COFFEE, TEA, MATE &

SPICES”, are among the top 10 products. Five products belonging to chapter 8, “ED. FRUITS & NUTS, PEEL OF CITRUS/MELONS”, are among the bottom 10 products. This result may be closely related with the pesticide residue testing report based on USDA data. The Environmental Working Group analyzed USDA pesticide residue data and they identified 12 dangerous fruits and vegetables which contain the highest pesticide residuals. According to their report in 2016, only 4 are vegetables among these 12 (https://www.ewg.org/foodnews/list.php). This suggests that fruits are more dangerous with respect to pesticide residuals compared to vegetables.

Table 2.4 Top 20 U.S. Vegetable Importing Countries (2015)

Rank	Market	Export ($1 million)	Rank	Market	Export ($1 million)
1	China	264	11	Hong Kong	23
2	Canada	137	12	Nigeria	21
3	Mexico	108	13	Netherlands	19
4	Japan	102	14	Turkey	18
5	Korea	45	15	India	18
6	Germany	32	16	Bangladesh	17
7	Taiwan	31	17	Vietnam	16
8	Spain	29	18	Italy	15
9	Indonesia	25	19	Philippines	14
10	Colombia	25	20	Saudi Arabia	13

Export data were collected from the United States International Trade Commission (USITC). Table 2.4 shows the top 20 destinations for U.S vegetable exports. China is the leading destination; the GDP of China is the largest among U.S. importing countries in 2014 (World Bank Dataset). Canada, Mexico, and Korea rank 2nd, 3rd, and

5th, respectively, as destinations for U.S. vegetable imports. U.S. vegetable exports are likely stimulated by the North American Free Trade Agreement (NAFTA) and U.S.-Korea Free Trade Agreement (FTA).[7]

Data for GDP per capita came from the World Development Indicator of the World Bank in U.S. dollars. Data on distance, common official language, contiguity, and colonial experience were collected from Mayer and Zignago (2011).

2.6 The Empirical Model

The aim of our model is to measure the effect of the U.S. MRL protectionism index on U.S. vegetable exports. The gravity model was first introduced in physics and its basic elements have been used in empirically analyzing trade flows. This paper uses the gravity model, which has been shown to be powerful in explaining international trade flows (Cheng and Wall, 2005):

$$
\begin{aligned}
&Export^{k}_{us,j} \\
&= f(GDP_{us}, GDP_{j}, Dis_{us,j}, Com_{us,j}, Col_{us,j}, Con_{us,j}, MRL^{k}_{us}, MRL^{k}_{j})
\end{aligned}
\tag{3}
$$

where *us* is the exporting country (the United States), *j* is the importing country, and *k* is the product. *Export* is export value, *GDP* is gross domestic product per capita, *Dis* is the bilateral distance between the importer and the U.S., *Com* is a dummy variable to identify when there is a common official primary language between the importer and the U.S., *Col* is a dummy variable to identify a colonial experience between the importing country and the U.S., *Con* is a dummy variable to identify importing countries that are contiguous

[7] The NAFTA is the trilateral trade block in North America countries of U.S., Canada, and Mexico.

with the U.S., and *MRL* is the protectionism index calculated by the Maximum Residual Limits.

To estimate equation (1), we take the log of both sides of the equation. However, U.S. exports have many zeros because there are many vegetable products not exported to some destinations. The log of zero is not defined. Furthermore, there tends to be heteroscedastic errors in exports, which leads to biased estimators due to Jensen's inequality (Silva and Tenreyro, 2006). The multilevel model analysis is one of the methods used to solve this problem. The multilevel regression can model the heteroscedasticity problem directly by specifying cross-level interactions (Goldstein, 2011; Western, 1998). Many zeros in export observations are related to sample selection bias. Sample selection problems happen when samples are only observable under certain conditions. In our case, exports are observable when exports are greater than zero. Let us consider a two-level hierarchy model to check for sample selection problems (Grilli and Rampichini, 2005). A bivariate linear model with two level intercepts can be represented as:

$$\begin{aligned} Y_{ij}^{S} &= z_{ij}^{S}\theta^{S} + u_{i}^{S} + e_{ij}^{S} \\ Y_{ij}^{P} &= z_{ij}^{P}\theta^{P} + u_{i}^{P} + e_{ij}^{P} \end{aligned} \qquad (4)$$

where, i=1, 2, 3, …, I is the index of level two clusters (level 2); j=1, 2, 3, …, n_i is the index of the elementary level (level 1); two variables, Y_{ij}^{S} and Y_{ij}^{P}, are continuous response variables; S represents for a selection and P represents for a principal; z_{ij} are covariates at the level 1 or 2; θ are coefficients for these equations; u_i are level 2 errors and e_{ij} are level 1 errors; These errors follow these assumptions:

$$\begin{bmatrix} e_{ij}^{S} \\ e_{ij}^{S} \end{bmatrix} \sim iid\ N\left(0, \quad \begin{bmatrix} \delta_S^2 & \\ \delta_{SP} & \delta_P^2 \end{bmatrix}\right)$$

$$\begin{bmatrix} u_{ij}^{S} \\ u_{ij}^{S} \end{bmatrix} \sim iid\ N\left(0, \quad \begin{bmatrix} \tau_S^2 & \\ \tau_{SP} & \tau_P^2 \end{bmatrix}\right)$$

According to Grilli and Rampichini (2005), the multilevel model estimators are unbiased if the sample selection depends on unobserved factors at the higher (cluster) level or at the lower (elementary) level. In other words, if $\delta_{SP} = \tau_{SP} = 0$, then the multilevel model estimators are unbiased. In our dataset, the number of zero dependent observations is 365 among 3,267 observations. Thus, we may assume that there are no sample selection problems because their numbers are small. The multilevel model can also consider the endogeneity problem in the higher level (level 2) using the cluster mean of the covariate (Grilli and Rampichini, 2006).

Taking the log of both sides of equation (1) and capturing the cluster level (level-2) endogeneity by rescaling MRL protectionism index of importing countries, this paper uses the following level-1 model:

$$\begin{aligned} \ln(Export_{ij}^{k}) = \pi_{us,j}^{0} + \beta_{10}\ln(GDP_{us}) + \beta_{20}\ln(GDP_{j}) + \beta_{30}\ln(MRL_{us}^{k}) \\ + \pi_{us,j}^{4}\ln(CMRL_{j}^{k}) + \beta_{50}\ln(Dis_{us,j}) + \beta_{60}Com_{us,j} \\ + \beta_{70}Col_{us,j} + \beta_{80}Con_{us,j} + \varepsilon_{us,j}^{k} \end{aligned} \tag{5}$$

where, k is the level 1 (products), j is the level 2 (importing countries), $CMRL_j^k = MRL_j^k - \overline{MRL^k}$, ε_{ij} is the error term, $\pi_{us,j}^{0} = \beta_{us,0}^{0} + \delta_{us,j}^{0}$, and $\pi_{us,j}^{4} = \beta_{us,0}^{4} + \delta_{us,j}^{4}$.

A single-equation expression of this model is derived by substituting $\pi_{us,j}^{0}$ and $\pi_{us,j}^{4}$ into equation (4):

$$\begin{aligned}\ln(Export_{ij}^{k}) = {} & \left(\beta_{us,0}^{0} + \delta_{us,j}^{0}\right) + \beta_{10}\ln(GDP_{us}) + \beta_{20}\ln(GDP_{j}) \\ & + \beta_{30}\ln(MRL_{us}^{k}) + \left(\beta_{us,0}^{4} + \delta_{us,j}^{4}\right)\ln(CMRL_{j}^{k}) \\ & + \beta_{50}\ln(Dis_{us,j}) + \beta_{60}Com_{us,j} + \beta_{70}Col_{us,j} \\ & + \beta_{80}Con_{us,j} + \varepsilon_{us,j}^{k}\end{aligned} \tag{6}$$

We can rearrange equation (5) into the following equation by clustering the random and fixed parts:

$$\begin{aligned}\ln(Export_{ij}^{k}) = {} & \beta_{us,0}^{0} + \beta_{10}\ln(GDP_{us}) + \beta_{20}\ln(GDP_{j}) + \beta_{30}\ln(MRL_{us}^{k}) \\ & + \beta_{us,0}^{4}\ln(CMRL_{j}^{k}) + \beta_{50}\ln(Dis_{us,j}) + \beta_{60}Com_{us,j} \\ & + \beta_{70}Col_{us,j} + \beta_{80}Con_{us,j} + \delta_{us,j}^{0} + \delta_{us,j}^{4}CMRL_{j}^{k} + \varepsilon_{us,j}^{k}\end{aligned} \tag{7}$$

where $\beta_{us,0}^{0}$ denotes the intercept; β_{10}, β_{20}, β_{30}, $\beta_{us,0}^{4}$, β_{50}, β_{60}, β_{70}, and β_{80} represent the level-1 estimators; $\delta_{us,j}^{0}$, $\delta_{us,j}^{4}$, and $\varepsilon_{us,j}^{k}$ show the error terms. To be specific, $\delta_{us,j}^{0}$ indicates the level 2 error variance in the intercept and $\delta_{us,j}^{4}$ is the level 2 residual variance in the level-1 slope of $CMRL_{j}^{k}$. $\varepsilon_{us,j}^{k}$ indicates errors in the entire model subtracting the level-2 variances.

One difference between the multilevel model and regression model is the error terms. Equation (6) has three error terms; however, the regression model has one error term since the regression model does not model the hierarchy. For this reason, there are assumptions concerning the disturbances. The following five assumptions are common in the multilevel model and are used in the present analysis:

- $\mathrm{E}\left[\delta_{us,j}^{0}\right] = E\left[\delta_{us,j}^{4}\right] = E\left[\varepsilon_{us,j}^{k}\right] = 0$. There is no systematic parameter noise or level-1 noise in the model.

- $\mathrm{Var}\left[\delta_{us,j}^{0}\right] = \tau^{0}\tau^{0}$, $\mathrm{Var}\left[\delta_{us,j}^{4}\right] = \tau^{4}\tau^{4}$, $\mathrm{Var}\left[\varepsilon_{us,j}^{k}\right] = \delta^{2}$. All disturbance terms of level-1 and level-2 have a constant variance. The multilevel model estimators are based on these variance components.
- $Cov\left[\delta_{us,j}^{0}, \delta_{us,j}^{4}\right] = \tau^{0}\tau^{4}$. A correlation may exist between the level-2 disturbances on the intercepts and slopes. It is normal that the level-2 models with large slopes also have large intercepts or vice versa. Snijders and Bosker (1993) suggest a way to estimate this covariance term.
- $\delta_{us,j}^{0}\ and\ \delta_{us,j}^{4}$ follow the normally distribution.
- $Cov\left[\delta_{us,j}^{0}, \varepsilon_{us,j}^{k}\right] = Cov\left[\delta_{us,j}^{4}, \varepsilon_{us,j}^{k}\right] = 0$. The errors in level-2 and level-1 are uncorrelated. Steenbergen and Jones (2002) argued that this assumption is normally necessary for an identified model.

The level-2 disturbances can be derived from a bivariate normal distribution with a mean zero and a variance-covariance matrix, and the level-1 disturbance with a mean zero and the variance δ^{2}.

$$\begin{bmatrix}\delta_{us,j}^{0}\\ \delta_{us,j}^{4}\end{bmatrix} \sim \mathrm{N}\left[\begin{pmatrix}0\\0\end{pmatrix}, \begin{pmatrix}\tau^{0}\tau^{0} & \tau^{0}\tau^{4}\\ \tau^{4}\tau^{0} & \tau^{4}\tau^{4}\end{pmatrix}\right]$$

and (8)

$$\varepsilon_{us,j}^{k} \sim N(0, \delta^{2})$$

For the robustness check, this paper estimates the multilevel model without centering in the cluster value, with centering in the cluster value, and with the Poisson pseudo-maximum likelihood (PPML) estimation. The PPML method is also one of way to deal with zero observations in the export data (Silva and Tenreyro, 2006).

2.7 Empirical Results

Table 2.5 shows the random effects in both multilevel models and the log likelihood ratio test (LR test) for the linear model. The null hypothesis for the LR test is that the single level regression is better than the multilevel model. Our results show that both multilevel models with centering and without centering reject the null hypothesis of the zero random effects at the 1% significance level. Thus, we can conclude that the multilevel specification is preferred to the single level regression model for this application.

Table 2.5 Random Effects Test Results

	Multilevel Model Without Centering		Multilevel Model With Centering	
Random Effect Parameter	Estimate	Standard Error	Estimate	Standard Error
Constant	0.8712	0.0928	0.9286	0.0928
Ln (U.S. MRL index)	0.6698	0.3746	0.7739	0.3393
Correlation (Constant, Ln (U.S. MRL index))	-0.0261	0.3650	0.7917	0.4036
Standard deviation (Residual)	2.4590	0.0338	2.4573	0.0337
Log Likelihood Ratio Test for Multilevel Model vs Linear Regression				
Chi square	185.65		201.43	
p-value	0.0000		0.0000	

The estimation results for the U.S. MRL protectionism index's impact on U.S. vegetable exports are represented in Table 2.6. Results are presented for three multilevel models: without centering, with centering, and PPML. The log of U.S. GDP is omitted for all models because cross section data is used (U.S. GDP is redundant). The observation numbers in the multilevel and PPML models are different because of zero values. The PPML model can handle zeros while the other models cannot.

The coefficients for log of distance are insignificant in all three models at the 10% significant level. These results contrast with most gravity model results such as Montobbio and Sterzi (2013), Khadaroo and Seetanah (2008), and Patuelli et al. (2015). These studies found that distance has a negative effect on exports. Theoretically, distance is considered as a trade barrier (Tinbergen, 1962). However, technology growth in transportation may reduce the distance barrier for U.S. vegetable exporters. The U.S. exports many vegetables to Canada and Mexico, which are both close, but they are also contiguous to the U.S. Other countries close to the U.S. are Latin American and Caribbean countries, but they do not import vegetables from the U.S. Thus, the contiguity variable might be picking up most of the distance effects.

The coefficients for contiguity are positive for all three models, which is expected since trade between such countries is much easier. Interestingly, the empirical literature shows ambiguous results. Burger, et al. (2009) find a positive relationship between the contiguity and exports. However, Cheng and Wall (2005) find a negative relationship between contiguity and exports. Batra (2006) finds that the contiguity effect on exports is insignificant.

Table 2.6 Estimation Results for MRL Protectionism Impact on Exports

	Multilevel Model Without Centering	PPML	Multilevel Model With Centering
Ln (Importing Country's GDP)	0.126 (0.0949)	0.029 (0.1118)	0.083 (0.0938)
Ln (U.S. GDP)	Omitted	Omitted	Omitted
Ln (Importing Country's MRL index)	-1.094*** (0.2478)	-0.870*** (0.2495)	-
Ln (Importing Country's MRL Index)_Centered	-	-	-1.287*** (0.2727)
Ln (U.S. MRL index)	1.619*** (0.2131)	2.676*** (0.7166)	1.580*** (0.2126)
Ln (Distance)	-0.002 (0.2167)	0.247 (0.1767)	-0.072 (0.2158)
Contiguity	3.928*** (0.7819)	2.329*** (0.3259)	4.439*** (0.7517)
Colony	1.164** (0.5065)	0.325 (0.4166)	0.960* (0.5056)
Common Official Language	0.040 (0.2553)	-0.324 (0.2135)	0.206 (0.2559)
Constant	4.926** (2.2188)	7.970*** (1.2745)	5.649** (2.2142)
Log Likelihood	-6488.435	-1.651e+08	-6487.365
Observations	2768	3115	2768

Note: ***, **, * Significant 1%, 5%, and 10%, respectively. () is standard error

The colony experience has a positive effect on U.S. vegetable exports for both multilevel models; however, it is insignificant in the PPML model. These results are inconsistent with Montobbio and Sterzi (2013) that shows a negative relationship between the colony experience and exports. The U.S. has a colonial experience with

France, Philippines, Spain, and United Kingdom among the U.S. vegetable exporting partners.[8] France, Spain, and the United Kingdom are members of the Organization for Economic Co-operation Development (OECD) and developed countries. Thus, these countries have enough income to purchase U.S. vegetables.

The common official language does not have a significant effect on U.S. vegetable exports. This result is not consistent with related literatures such as Gómez-Herrera (2013), Montobbio and Sterzi (2013), Picci (2010), and Stack (2009). English is commonly used world-wide so having it as a mutual common official language may not be important (given the other variables in the model).

The coefficient for the importing country's MRL protectionism index has a negative effect on U.S. vegetable exports. This result is consistent with the impeding role of NTMs on exports. For example, Fontagné, et al. (2005) showed that NTMs have a negative effect on fresh and processed food. Disdier, et al. (2008) also found that SPS and TBT measures have a negative effect on agricultural product trade. Lower MRL levels by importers make it more difficult for U.S. vegetable exporters to reach the market in a competitive fashion.

The focus of this paper is the effect of the U.S. MRL protectionism index on vegetable exports. All three models show that the U.S. MRL protectionism index has a positive effect on U.S. vegetable exports. This result is consistent with the hypothesis presented earlier; that the signalling effect of the home country's strict food safety regulation may lead to increased exports. The results provide policy makers with insights

[8] U.S. was a colony of France, Spain, and United Kingdom. And, Philippine was a colony of U.S.

into how strict food safety regulations of the home country can be considered as a catalyst for increasing competitiveness in the international markets.

Table 2.7 shows the post-estimation results for the random effects model using the centered log of importing Country's MRL protectionism index on the U.S. vegetable exports. The multilevel model specification in this paper defines the centered log of importing country's MRL protectionism effect on U.S. vegetable exports as the fixed part ($\beta^4_{us,0}$) and random part ($\delta^4_{us,j}$). The fixed part represents the average effect and the random part indicates the deviation from the average effect according to the importing country level (level 2). In other words, the random part represents errors in level 2 effects. The post-estimation method allows us to calculate level 2 errors ($\delta^4_{us,j}$). If country A's random error in level 2 ($\delta^4_{us,j}$) has a positive value, then country A has a higher centered log of importing country's MRL protectionism effect on U.S. vegetable exports compared to the average importing country.

Table 2.7 presents the top and bottom 10 countries for the random effect. Top 10 countries indicate that the effect of importing country's MRL protectionism index on U.S. vegetable exports is high compared to other countries and vice versa in the bottom 10 countries. The average GDP of the Top 10 countries is higher than the bottom 10 countries, however, the difference is only $888. Considering that income level is a key factor in the demand for higher food safety regulations, the small GDP difference between the top 10 and bottom 10 countries may indicate that political economic views are important. Götz et al. (2010) argued that governments increase non-tariff barriers such as SPS regulations to protect their producers. The government intention for protecting their producers may be an important factor explaining the effects of the MRL protectionism index.

Table 2.7 Top and Bottom 10 of Post-Estimation Results for Random Effects

Rank	Country	GDP	Post-Estimator
Top 10 countries			
1	Iceland	52,004	-1.0952
2	Paraguay	4,713	-1.0659
3	Brunei	40,980	-0.9183
4	Fiji	5,112	-0.8529
5	Cyprus	27,194	-0.8426
6	Slovenia	23,999	-0.8289
7	Bahrain	24,855	-0.7222
8	Austria	51,191	-0.6527
9	Czech Republic	19,530	-0.6515
10	Barbados	15,366	-0.6358
Average		26,494	-0.8266
Bottom 10 countries			
Rank	Country	GDP	Post-Estimator
1	Japan	36,194	2.0872
2	China	7,590	1.5172
3	Indonesia	3,492	1.1737
4	Korea	27,970	1.0923
5	Netherlands	52,172	0.8220
6	Hong Kong	40,170	0.7221
7	Turkey	10,515	0.6472
8	Saudi Arabia	24,161	0.6314
9	Thailand	5,977	0.5958
10	Germany	47,822	0.5623
Average		25,606	0.9851

2.8 Conclusions

In this paper, we investigate the signalling effect of exporters from countries that have high domestic levels of MRL standards. *A priori*, we expected that the home country’s strict food safety standards could provide a signalling effect that might enhance exports to other countries that have high standards. To be specific, we investigate the relationship between the U.S. MRL protectionism index and the U.S. vegetable exports.

The results show that the U.S. MRL protectionism index has a positive impact on the U.S. vegetable exports, indicating that the home country's strict standards provide a signalling effect to firms in the home country exporting to foreign destinations with high food safety regulations.

The results of this paper also show that the importing countries' MRL protectionism index has a negative effect on the U.S. vegetable exports. This is also reasonable since the MRL regulation is considered to be an NTB related to food safety. Previous literature on non-tariff barrier effects has also found a similar negative relationship with exports (Disdier and Marette, 2010). This negative relationship stems from the difficulty of meeting strict food safety regulations, such as the MRL.

Using the post-estimation method, we also represent the random effect in the centered log of importing Country's MRL protectionism index ($\delta^4_{us,j}$) on U.S. vegetable exports. The random effect results indicate that the average GDP difference between top 10 and bottom 10 countries is very small. This result gives us some insights into political economic views about non-tariff barriers. Political economists argue that governments use non-tariff barriers as a tool for protection of their domestic producers. Those arguments are compatible with our results. Our results show that strict food safety regulations are influenced by income levels; the income level difference in top and bottom 10 countries was $888.

These results have implications for firms and government policy makers. Firms may think that strict food safety regulations in the home country are just costs that must be incurred with no benefit. However, the home country's strict regulation can be considered as an opportunity when firms sell their products in foreign markets that have high food safety regulations. Firms can recoup some of their investment costs by exporting to other countries that value safer foods. These findings suggest that governments might wish to re-evaluate their food safety regulations. Governments that simply set food safety regulations for the health of their people underestimate the export benefits from stricter regulations. Stricter regulations can have a role in enhancing producers' competitiveness by providing them the learning effect advantages as food regulations increase throughout the world.

This study only focuses on U.S. vegetable exports. To generalize the results, future studies are needed to consider other countries and other agricultural products. Furthermore, the empirical work can expand to incorporate other NTMs that influence trade and measuring their effects. The MRL protectionism index in this study only focuses on the pesticide residual level and this paper only uses data for 2015 in the analysis due to limitations in the MRL data. This analysis could include a time component as data is collected for the future years.

Chapter Three

Political Determinants of SPS Notifications: Testing the Law of Constant Protection and Food Safety Demand

3.1 Introduction

Trade barriers are divided into tariff and non-tariff barriers. Recently, the importance of non-tariff barriers has been growing compared to tariff barriers, likely because there has been a steady decrease in tariff barriers through the various rounds of multilateral trade negotiations (Dean et al., 2009). For example, the General Agreement on Tariffs and Trade (GATT) and World Trade Organization (WTO) rules and regulations have resulted in the reduction of tariffs, which has increased competitiveness pressures on domestic producers. The worldwide trend of free trade agreements (FTA) and multinational trade agreements, such as the North American Free Trade Agreement (NAFTA), has also lowered tariff rates. These lower tariff barriers have increased the importance of NTBs, and for this reason, there is heightened interest in the research community to study NTBs. Most of the studies on NTBs, however, focus on measuring NTBs (Disdier and Tongeren, 2010; Looi Kee et al., 2009), or the effects of NTBs on trade flows (Andriamananjara et al., 2004; Dal Bianco et al., 2016).

In studies of NTB determinants, some political economists, such as Mansfield and Busch (1995), find a substitute relationship between tariff barriers and non-tariff barriers. They argue that countries want to protect their producers from reduced tariffs by increasing non-tariff barriers. This relationship is conceptualized by the law of constant protection (Bhagwati, 1989), where countries prefer to protect their domestic producers at a constant rate; so if tariffs are lowered, non-tariff barriers must increase. However, there is a different political economy view related to the law of constant protection. Mansfield and Busch (1995) referenced studies for a complementary role of NTBs such as Ray (1981). They argue that countries mostly use NTBs in industries with high tariff barriers. For example, Ray (1989) showed that the U.S. had a tendency to protect industries which were least affected by the GATT compared to industries which were most affected by the GATT.

Empirical studies for the determinants of NTBs and the law of constant protection such as Mansfield and Busch (1995) and Ray (1989) focus on all industries using 4-digit or 6-digit Harmonized System (HS) level data. However, these studies use all industries data without considering the characteristic of each industry. In other words, these empirical researches focus on the NTBs that are adaptable to all industries. Each industry has different NTBs based on its unique characteristics compared to other industries. Industries in the agricultural and food sector, in particular, have different characteristics than other industries because NTBs for agricultural and food industries heavily depend on food safety regulations that have specific health-related targets. Normally, the purpose of NTBs, such as quotas, is solely protecting domestic industries and firms. Nevertheless, NTBs related to food safety regulations have the purpose of enhancing and protecting public health, as well as protecting home country industries. Thus, when we study the determination of NTBs and the law of constant protection in the agri-food sector, we have to consider the influence of increased food safety demand over time as technology becomes more available and as consumers become wealthier.

Empirical studies for determining NTBs or testing the law of constant protection, such as Lee and Swagel (1997) and Mansfield and Busch (1995), also include tariff rates and other political factors as independent variables. These studies assume that the relationship between independent variables (tariff rates, GDP per capita, and other political factors) and the dependent variable (NTBs) is linear. However, it is likely that their effects on NTBs vary based on the original tariff rates or GDP per capita levels. Two possible nonlinearities exist -- by tariff rates or GDP per capita. First, the effects of a tariff rate reduction on NTBs may be different according to the original tariff rate. For example, if the original protection level is high, then a politician may react strongly to a tariff reduction since the industry with high protection normally has a competitive disadvantage. Second, the effect of increasing wealth or GDP per capita on NTBs for food safety may be different according to the original GDP per capita level. For example, a wealthy country may experience fewer or less stringent NTBs for food safety since it may already have high food safety regulations. Thus, this paper tests nonlinearity in these relationships that may be from GDP per capita or tariff rates. The existence of nonlinearities will imply different policy effects as countries develop and liberalize trade.

Among NTBs in the agricultural sector, this paper chooses SPS notifications by the WTO. First, there has been a large decrease in non-tariff (not related with food safety) and tariff barriers, which increased the importance of SPS barriers (Jongwanich, 2009). Second, SPS notifications cover a wide range of characteristics for food safety. The WTO requires that the application of SPS is based on scientific evidence and the SPS has a purpose to protect animal, plant, or human health based on scientific evidence (Liu and Yue, 2009). Last, SPS notifications in the WTO have a detailed dataset. The WTO reports SPS notifications every year for each country, each product, and each notification reason (WTO-SPS Information Management System).

This paper investigates the political determinants of SPS regulations as well as the impact of tariff reductions on SPS notifications (NTBs related with food safety issues) in the agricultural sector to test whether political economic views (such as the law of constant protection) are present. This study also explores the impact of GDP per capita on SPS notifications in the agricultural sector to test whether income derives food safety regulations. Furthermore, this paper tests for threshold nonlinearity in variables of tariff rate and GDP per capita using the method suggested by Hansen (2000). The estimation method for political determinants of SPS notifications is the fixed effect Tobit model because this paper's dependent variable, the number of SPS notifications, has many zero values.[9]

The findings from this paper contribute to the existing empirical approaches about political determinants for non-tariff barriers that are available for the manufacturing sector. Yet this approach is different compared to the existing studies because it focuses on non-tariff barriers in the agricultural sector. A new explanatory variable compared to the existing studies is introduced, i.e., GDP per capita, since food safety demand influences non-tariff barriers in the agricultural sector. Moreover, this paper incorporates threshold non-linearity in the political determinants of non-tariff barriers.

[9] This paper's threshold non-linearity test shows that there is no threshold non-linearity for tariff rates and GDP per capita.

3.2 Literature Reviews

Trade liberalization, the reduction of tariff and non-tariff barriers, has a positive effect on productivity (Yu, 2015). According to Dornbusch (1980), country A has a competitive advantage over other countries if the country A has a lower production cost, which is related to productivity. In other words, if the country A has high productivity, then it has a competitive advantage. This competitive advantage can be linked with exports since firms will export when they have a competitive advantage (Salomon and Shaver, 2005). Exports can be a source of the economic development since exports are factors for increasing aggregate output (Awokuse, 2006). Thus, trade policies have an important role in exports and development. For this reason, figuring out the determinants of trade policies is important.

Historically, traditional economists studied the determinants of trade policies such as trade barriers in terms of an economic and political view (Baldwin, 1982). An economic approach focuses on the trade liberalization effect. In other words, an economic view emphasizes the reduction of tariff and non-tariff barriers and their effect on exports or welfare. Political approaches are a common and reasonable way to study determinants of trade barriers since trade barriers exist even if there is a consensus that free trade is economically efficient (Lee and Swagel, 1997).

Studies for determinants of trade policy mainly take a political economic approach, which can be divided into societal and statist approaches (Mansfield and Busch, 1995). The literature on societal approaches focuses on pressure groups that forces politicians to protect them by enacting policies that are friendly to their concerns. This is because a small group of stakeholders normally enjoys the benefits of trade protection, while a larger number of customers typically shares costs of trade protection. Under this circumstance, a narrow group of stakeholders has a tendency to lobby politicians intensively while consumers do not (Lee and Swagel, 1997). Furthermore, it is well known that politicians make their choice based on their political benefits rather than voter's economic interests (Biglaiser and Mezzetti, 1997). For example, Harrington (1993) argued that politicians employ policies to increase their probability for reelection. Biglaiser and Mezzetti (1997) also showed that the reelection plays a key role in politicians' decision-making. Some studies for societal approaches are characterized as endogenous protection (Carter et al., 1990; Nelson, 1988; Rodrik, 1994). However, societal approaches are criticized because they do not recognize the importance of large states (or industries) on trade policy (Goldstein, 1988; Gourevitch, 1986). It is argued that societal approaches underestimate the power of these important groups on trade liberalization.

Statist approaches focus on how politicians make trade policy, where societal pressures are constant (Mansfield and Busch, 1995). In other words, statist approaches focus on the effects of policies on the national interest rather than pressure groups. Two factors, relative size and domestic institutions, are represented as statist approach variables (Mansfield and Busch, 1995). First, the state's economic size dominates its national interest in terms of trade policy. Large states (industries) have disproportionately large market power compared to small states (industries) (Dornbusch, 1993). Thus, large states or industries have more power to influence trade policy compared to small states or industries. In other words, the trade policy tends to benefit large states or industries, which indicates that national interests are satisfied compared to the trade policy for small states of industries. The second factor is domestic institutions. Mansfield and Busch (1995) cited the study of Rogowski (1987) for the importance of regional institutions. Rogowski (1987) insists that a large number of domestic institutions are helpful to make trade policy for a whole state or industry rather than small members in a state or industry.

A study specifically addresses the political relationship between tariff and non-tariff barriers. Bhagwati (1989) suggests the “law of constant protection”, which indicates that tariff reductions cause increases in non-tariff barriers. In other words, his argument points to a displacement effect between tariff and non-tariff barrier. However, there is also a strain of the political economic approach that focuses on the complementary relationship between tariff and non-tariff barriers (Mansfield and Busch, 1995). For example, Ray (1989) found that U.S. industries least affected by the General Agreement on Tariff Trade (GATT) have higher NTBs. In other words, the complementary relationship between tariff and non-tariff barriers indicates that governments may set high NTBs for industries with high tariff rates. There are many theoretical studies for the relationship between tariff reductions and NTBs, but few empirical studies (Aisbett and Pearson, 2012). Feinberg and Reynolds (2007) argue that a decrease in tariff barriers leads to an increase in the likelihood and number of anti-dumping petitions. Aisbett and Pearson (2012) also show that tariff reductions increase the SPS notification numbers.

There are several empirical studies dealing with the political determinants of trade barriers. Considering the societal approaches and the effects of trade barriers on trade flows, there is a need to take into account the simultaneous determination process between trade barriers and trade. Interest groups have an incentive to lobby for their protection if there is an increase in import competition from trade liberalization (Baldwin, 1985; Magee et al., 1989). At the same time, trade barriers, which come from lobbying activities of interest groups, affect trade flows. Thus, some studies on the determinants of trade barriers take into account the simultaneous relationship between trade barriers and trade; incorporating the possibility that trade barriers can affect trade and trade can affect trade barriers. Ray (1981) investigated the determinants of imports and trade barriers with a simultaneous relationship using data from U.S. manufacturing industries in 1970. He showed that industrial characteristics such as labor intensity and capital/labor ratio have a different effect on tariff and non-tariff barriers when allowing for a simultaneous relationship between imports and trade barriers. Trefler (1993) also studied the determinants of U.S. trade and NTBs using a simultaneous equation model.

Some studies for the determinants of trade barriers do not consider the simultaneous relationship between trade barrier and trade. Ray and Marvel (1984) estimated the determinants of U.S. tariffs and NTBs separately using four-digit manufacturing data. Lee and Swagel (1997) also investigated the determinants of non-tariff barriers using disaggregated data from 41 countries in 1988. Jongwanich and Kohpaiboon (2007) investigated the determinants of protection in Thai manufacturing industries considering supply and demand factors.

Most studies on the determinants of NTBs are based on political economy and the relationship between tariff reductions and NTBs are not focused on the agricultural sector. As Aisbett and Pearson (2012) showed, non-tariff barriers in agricultural sectors have different characteristics than manufacturing sectors since non-tariff barriers in agriculture often depend on food safety issues. For example, SPS regulations are used for protecting human, plant, and animal health (Aisbett and Pearson, 2012). For this reason, there is a need for studying political determinants of non-tariff barriers in agricultural industries considering the relationship between tariff reductions and non-tariff barriers. Even though Aisbett and Pearson (2012) focused on SPS notification numbers and agricultural non-tariff barriers, they did not consider political economy factors. Furthermore, they did not allow for non-linearity in the determinants of SPS notifications. Finally, they did not account for problems associated with zero observations in the dependent variable. For this reason, this paper investigates non-linearity in political determinants of SPS notifications.

3.3. Model of Political Determinants of Non-Tariff Barriers

Societal and statist approaches are prevalent in studies on the determinants of non-tariff barriers (Mansfield and Busch, 1995). Societal approaches focus on the role of pressure groups on political choices. However, societal approaches are criticized by statist approaches due to the underestimation problem. The statists argue that societal approaches underestimate the effects of state interests and domestic institutions (Goldstein, 1988). Mansfield and Busch (1995) also argue that the statist approach has little support from quantitative evidence. They suggest that societal and statist approaches are considered as complementary. Thus, this paper combines societal and statist approaches to the empirical model.

Following the societal approach, this paper uses unemployment and exchange rate as explanatory variables. The societal approach argues that competition between pressure groups and non-state players determines a trade policy. In other words, the effect of pressure groups on politicians or policy makers is the key factor for a determination of trade policy. Thus, we can expect that macroeconomic fluctuations are important factors for the societal approach since pressure groups have an incentive to force politicians to change trade policy for dealing with macroeconomic fluctuations. This procedure for the determination of trade policy is called endogenous protection (Nelson, 1988; Ray, 1989; Rodrik, 1994). Fluctuations in macroeconomic variables affect trade policies as shown in studies such as Baldwin (1989), Bergsten and Cline (1983), and Salvatore (1993). Among macroeconomic variables, the unemployment and exchange rate are the key variables for the societal approach (Mansfield and Busch, 1995; Ruggie, 1982). A higher unemployment rate leads to an increase in import restrictions since the unemployment rate imposes costs from job losses. Fluctuations in the exchange rate also lead to increased protection since exchange rate variations cause concerns to firms (Dornbusch and Frankel, 1987).

Statist approaches focus on the role of national interests and domestic institutions on the determination process of trade policy. Mansfield and Busch (1995) argued that an industry's relative size, such as the ratio of that industry's imports to total imports and the ratio of that industry's GDP to global GDP, represents the national interest. Therefore, national interest can be different across states, regions, or industries. Larger states, regions, or industries may have a disproportionately larger market power (Dornbusch, 1993). Governing states, regions, or industries act in an economically predatory manner for a trade protection (Gilpin, 2016).[10] For example, the manufacturing industry in Korea pushes politicians to enact trade policy that emphasizes the important role of the manufacturing sector, which leads to trade policies that sacrifice the agricultural industry

[10] In our model, we capture governing industries using the GDP of agriculture relative to the total economy.

in Korea.[11] It is well shown in the U.S.-Korea Free Trade Agreement which is beneficial to manufacturing sectors but harmful to agricultural sectors (Cooper et al., 2012).

Large states or industries have a high degree of institutional insulation and autonomy, which means that large states or industries may have an organized institution to force policy makers to enact favorable policies for them.[12] Thus, politicians have an incentive to impose NTBs in states or industries of well-organized domestic institutions (Mansfield and Busch, 1995). Rogowski (1987) captures well-organized domestic institutions in his analysis by the number of domestic institutions. However, it is hard to gather useful data for domestic institutions. For this reason, this paper does not include variables for domestic institutions. Considering the high correlation between well-organized (and large) domestic institutions and larger states, using the relative state size may capture the effects of domestic institutions also.

This paper also considers the substitution effect between tariff and non-tariff barriers by adding the tariff rate as an independent variable. The tariff rate is assumed as exogenous from NTBs, as assumed by Lee and Swagel (1997), because tariff rates for many nations have decreased due to the free trade trend within the World Trade Organization (WTO) and other multinational agreements. Furthermore, Ray (1981) found that NTBs are not affected by tariffs.

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[11] According the World Bank dataset in 2014, the GDP share of agriculture in Korea is 2.4% and the GDP share of manufacturing in Korea is 38.7%.

[12] In Korea's case, manufacturing companies such as Samsung, Hyundai, and LG are part of the Federation of Korean Industries (FKI), which has pushed policy makers since 1961 (http://terms.naver.com/entry.nhn?docId=2837041&cid=50867&categoryId=50867). FKI's purpose is to propose policies to the government for their benefits (http://terms.naver.com/entry.nhn?docId=2837041&cid=50867&categoryId=50867).

Finally, this study considers food safety demand by including GDP per capita, since SPS notifications reflect the demand for higher food safety regulations. A product with higher food safety standards may be considered a higher quality product compared to a product with lower food safety standards. Consumption of high quality products increases consumer satisfaction (Juran, 1999). Thus, GDP per capita may be a proxy variable for food safety demand since high-income people are more sensitive to quality issues compared to low income people.

Table 3.1 Independent Variable Specification

Independent Variable	Role
Unemployment Rate	Societal Approach
Exchange Rate	Societal Approach
National Interest (Relative Size)	Statist Approach
Tariff Rate	Capture the Substitution Effect Between Tariff and SPS
GDP per capita	Capture the Demand for Products with High Food Safety Regulations

Table 3.1 presents the independent variables in the specification. The unemployment and exchange rate represent the societal approach. The relative size (national interest) indicates the statist approach. The tariff rate captures the substitution effect between tariff and SPS notifications. GDP per capita captures the demand for products with high food safety regulations.

In summary, the model specification for this paper is:

$$SPS_{it} = f(Unemployment\ Rate_{it}, Exchange\ Rate_{it}, Relative\ Size_{it}, Tariff_{it}, GDP_{it}) \tag{9}$$

where i is country, t is year, *SPS* is SPS notification numbers, *Unemployment Rate* is the unemployment rate in the agricultural sectors, *Exchange Rate is the official exchange rate*, *Relative Size* is the percentage of GDP from the agricultural sectors. *Tariff* is the tariff rate for agricultural sectors, and *GDP* is GDP per capita.

3.4 Data Description

A new generation of regional trade agreements has appeared in the 21st century that lower tariff barriers (Friel et al., 2013). For this reason, this paper focuses on the period 2000 to 2014. Among non-tariff barriers, this paper chooses SPS notifications mainly because we want to focus on agricultural sectors, which have different characteristics compared to manufacturing sectors. First, non-tariff barriers in agricultural sectors are heavily dependent on food safety regulations. Jongwanich (2009) argues that the importance of SPS has an increasing trend in agricultural sectors since there is a large decrease in tariff and non-tariff (not related with food safety) barriers. Second, SPS notifications, which are notified by each country to WTO, are based on scientific evidence. Last, the WTO has a detailed dataset for SPS notifications which includes year, product, and notification reason for each (WTO SPS Information Management System). Data on SPS notifications in WTO have many zeros, so this paper uses the Tobit model to handle the zeros in the dependent variable. After the left censoring (based on 0) by the Tobit model, we have 103 countries among the original 218 countries. Data on SPS notifications is gathered from the integrated trade intelligence portal of the WTO.

We use the simple tariff rate from the trade analysis information system of the United Nations Conference on Trade and Development (UNCTAD). As seen from table 3.2, there is an increasing trend in SPS notifications, while there is a decreasing trend in tariff rates. These trends may represent a substitute relationship between tariff and non-tariff barriers.

Table 3.2 SPS Notifications and Tariff Rates 2000 to 2014

Year	The average of SPS notifications among countries	The sum of SPS notifications among countries	The simple tariff mean among countries
2000	0.78	174	21.19
2001	1.70	377	19.00
2002	1.53	340	18.50
2003	1.62	360	19.52
2004	1.47	327	17.01
2005	1.41	313	17.53
2006	1.82	403	17.74
2007	2.40	532	18.32
2008	3.71	823	17.39
2009	2.99	663	17.39
2010	3.62	803	16.70
2011	3.45	766	16.27
2012	2.98	661	15.12
2013	3.32	738	15.93
2014	4.21	934	15.02

Source: Author's calculation based on the WTO database

Data on GDP per capita comes from the World Bank database. As shown in Figure 3.1, the average GDP per capita among the 218 countries has an increasing trend.

This trend shows that there is a tendency of increasing demand for food safety over time (or as GDP per capita increases).

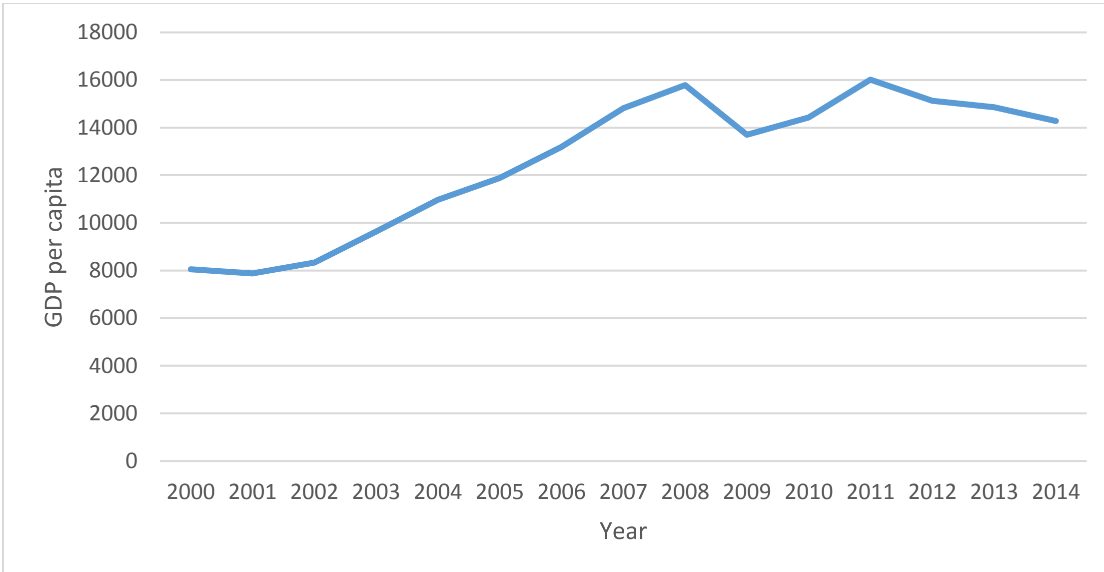

Figure 3.1 The average GDP per capita among 218 countries

Source: Author's calculation based on the World Bank Database

The relative size of agricultural sector is defined in this paper by agricultural value added per worker and GDP per capita from the World Bank Database. The relative size of the agricultural sector is calculated by the following equation:

$$Relative\ Size\ of\ Agricultureal\ Sector_{it} = 1 - \frac{Agricultural\ Value\ Added\ per\ worker_{it}}{GDP\ per\ capita_{it}} \quad (2)$$

The agricultural unemployment rate is derived from data on the total labor force, unemployment total (%), employment in agricultural sectors (%), and rural population datafrom the World Bank Data base. The calculation procedure is composed following three steps of equations.

First Step

$$\begin{aligned} &Total\ Employment\ Number_{it} \\ &\quad = Total\ Labor\ Force\ Number_{it} \times (1 \\ &\quad - Unemployment\ Total\ (\%)_{it}) \end{aligned}$$

Second Step

$$\begin{aligned} &Agricultural\ Employment\ Number_{it} \\ &\quad = Total\ Employment\ Number_{it} \\ &\quad \times Employment\ in\ Agricultural\ Sectors\ (\%)_{it} \end{aligned} \tag{3}$$

Third Step

$$\begin{aligned} &Unemployment\ Rate\ in\ Agricultural\ Sector_{it} \\ &\quad = 1 - \frac{Agricultural\ Employment\ Number_{it}}{Rural\ Population_{it}} \end{aligned}$$

3.5 Testing the Threshold Non-linearity

Panel data often have a heterogeneity problem due to the fact that the structural relationships may differ according to each industry or individual (Wang, 2015). However, the traditional models for fixed or random effects only consider intercept heterogeneity (Wang, 2015). There are ways of capturing slope heterogeneity using the threshold nonlinearity concept. However, most papers focus on time-series data, such as Tong (2012) who deals with nonlinear time series data using threshold autoregressive model. Hansen (2000) suggests a simple way to find the threshold value (slope and intercept heterogeneity) in the normal regression form. For this reason, this paper follows the Hansen (2000) method for estimating the threshold values and testing for threshold non-linearity. The basic threshold model is:

$$y_i = \theta_1' x_i + e_i \quad if \;\; q_i \leq \gamma$$
$$y_i = \theta_2' x_i + e_i \quad if \;\; q_i > \gamma \tag{4}$$

where q_i is the threshold variable, y_i is dependent variable, x_i is an independent variable matrix, e_i is the error term, and γ is a threshold value which divides the sample into two. The two groups are called "regimes".

Combining the equations in (4), Hansen (2000) defines a dummy variable $d_i(\gamma) = 1, where\ \{q_i \leq \gamma\}$. He also assumes that $x_i(\gamma) = x_i d_i(\gamma)$.

$$y_i = \theta' x_i + \delta_n' x_i(\gamma) + e_i \tag{5}$$

where $\theta = \theta_2$.[13]

To put the model in matrix notation, Hansen (2000) defines the n×1 vectors Y and e by stacking variables y_i and e_i. He also defines X and X_γ as n $\times\ m$ vectors by stacking vectors x_i' and $x_i(\gamma)'$.

$$Y = X\theta + X_\gamma \delta_n + e \tag{6}$$

One can estimate the parameters $(\theta,\ \delta_n,\ \gamma)$ by minimizing the following least square (LS):

$$argmin\ S_n(\theta, \delta, \gamma) = (Y - X\theta - X_\gamma \delta_n)'(Y - X\theta - X_\gamma \delta_n) \tag{7}$$

Least squares estimators $\hat{\theta}, \hat{\delta}, \hat{\gamma}$ jointly minimize the above sum of square errors. Hansen (2000) suggested the easiest method to obtain the LS estimators is by using the

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[13] θ_2 exists in equation (4).

concentrated sum of squared errors function. We can rewrite equation (7) conditional on γ, which allows us to regress Y on $X_\gamma^* = [XX_\gamma]$, and obtain the conditional OLS estimators $\widehat{\theta(\gamma)}$ and $\widehat{\delta(\gamma)}$.

$$S_n(\gamma) = S_n\left(\widehat{\theta(\gamma)}, \widehat{\delta(\gamma)}, \gamma\right) = Y'Y - Y'X_\gamma^*(X_\gamma^{*\prime}X_\gamma^*)^{-1}X_\gamma^{*\prime}Y \tag{8}$$

where $\hat{\gamma}$ minimizes the concentrated sum of squared errors function $S_n(\gamma)$.

After this estimation, one tests the null hypothesis (H_0: $No\ threshold$)since there needs to be a statistical check for the threshold point. In our case, the threshold variables (q) are GDP per capita and tariff rate. The following equations (9) represent this paper's threshold model.

$$\begin{aligned} Ln(1+SPS_{it}) = \beta_0^1 &+ \beta_1^1 Ln(Unemployment\ Rate_{it}) \\ &+ \beta_2^1 Ln(Exchange\ Rate_{it}) + \beta_3^1 Ln(Relative\ Size_{it}) \\ &+ \beta_4^1 Ln(Tariff_{it}) + \beta_5^1 Ln(GDP_{it}) + e_{it}^1 \quad if\ \ q_{it} > \gamma \\ Ln(1+SPS_{it}) = \beta_0^2 &+ \beta_1^2 Ln(Unemployment\ Rate_{it}) \\ &+ \beta_2^2 Ln(Exchange\ Rate_{it}) + \beta_3^2 Ln(Relative\ Size_{it}) \\ &+ \beta_4^2 Ln(Tariff_{it}) + \beta_5^2 Ln(GDP_{it}) + e_{it}^2 \quad if\ \ q_{it} > \gamma \end{aligned} \tag{9}$$

where, q is GDP per capita or tariff rate.

This paper has two threshold non-linearity hypothesis tests. The first null hypothesis is "There is no threshold relationship based on GDP per capita". We expect that there is a threshold non-linearity based on GDP per capita. It is believed that GDP per capita has an effect on SPS notification variations, which indicates that food safety demand is expected to differ according to income level (GDP per capita). If we reject this hypothesis, we can argue that countries with a GDP per capita above a particular level may be more sensitive to food safety considerations compared to countries with GDP per capita below that level.

The second null hypothesis is "There is no threshold non-linear relationship based on tariff rates". We expect that there is a threshold non-linearity based on tariff levels. It is believed that the original protection level regulated by tariff rates is an important factor with respect to SPS notifications. We believe there is a substitute relationship between tariff and SPS notifications, but this relationship may be different according to the original tariff level. If we find threshold non-linearity based on tariff rates, we can argue that politicians may consider a tariff reduction effect on industries differently depending on whether the tariff was high or low.

3.6. Empirical Model

This paper uses the Tobit method to estimate the model because it can deal with many zeros in the dependent variable (Melitz, 2003). The fixed effects Tobit model is used since the dataset is panel. The same cross section data at different points in time (panel data) may bring about unobserved effects (Wooldridge, 2010). These effects may be related to the omitted variables, which lead to endogeneity problems. Furthermore, these unobserved effects may represent unobserved heterogeneity (Wooldridge, 2010). To solve this omitted variable problem and unobserved heterogeneity from unobserved effects, this paper uses the fixed effect Tobit model.[14] The following equation is a logarithmic functional form of equation (1).

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[14] The basic form of unobserved effects model is represented as:

$$y_{it} = x_{it}\beta + c_i + u_{it}, \ \ t = 1,2,\ldots\ldots,T$$

where, x_{it} is a 1×K vector, i is individual, t is time, c is an unobservable factor, and u is a random error.

$$
\begin{aligned}
Ln(1 + SPS_{it}^{*}) = \beta_0 + \beta_1 Ln(Unemployment\ Rate_{it}) \\
+ \beta_2 Ln(Exchange\ Rate_{it}) + \beta_3 Ln(Relative\ Size_{it}) \\
+ \beta_4 Ln(Tariff_{it}) + \beta_5 Ln(GDP_{it}) + u_i + e_{it}
\end{aligned} \tag{10}
$$

$$
SPS_{it} = \begin{cases} SPS_{it}^{*}, & if\ SPS_{it}^{*} > 0 \\ 0, & otherwise \end{cases}
$$

where, i is country, t is year, *SPS* is the number of SPS notifications, *Unemployment Rate* is the unemployment rate in the agricultural sectors, *Exchange Rate is the official exchange rate*, *Relative Size* is the relative GDP of agricultural sectors, *Tariff* is the tariff rate for agricultural sectors, *GDP* is GDP per capita, u_i is a fixed effects term, and $e_{it} \sim i.i.d. N(0, \delta^2)$.

The model is also estimated with the Poisson pseudo-maximum likelihood (PPML) method to provide a robustness test. This method, suggested by Silva and Tenreyro (2006), can deal with many zeros in the dependent variable. Silva and Tenreyro (2011) also showed that the PPML estimators perform well even if the dataset has a large number of zeros. Another simple way to deal with many zeros in the dependent variable is adding 1 to the dependent variable (Baldwin and Nino, 2006; Gómez-Herrera, 2013). However, this method has a problem with biased coefficients (Baldwin and Nino, 2006; Bergijk and Oldersma, 1990; Wang and Winters, 1992). Nonetheless, this paper also provides results from the fixed effects panel model estimator when adding 1 to the dependent variable. This also provides a robustness check.

3.7. Results

Table 3.3 represents the test results of the null hypothesis that there is no threshold against the alternative hypothesis that there is a threshold on variable effects.

The null hypothesis that there is no threshold cannot be rejected for both threshold variables (GDP per capita and tariff rate) at the 5% significance level. These results have two implications. First, there is no difference between high and low income countries in terms of their sensitivity for food safety demand, since there is no threshold based on GDP per capita. The food safety demand is closely related with quality demand for food since food safety is one of components for quality of food products. Thus, our result is consistent with Seok et al. (2016) that showed there is no difference in quality demand between OECD and non-OECD countries. Since there is no difference in food safety demand according to the income level, quality competition on food safety demand may be more important than price competition. At a minimum, low and high income countries do not have different preferences for food safety.

Table 3.3 Test of Null of No Threshold against Alternative of Threshold

Threshold Variables	GDP per capita	Tariff Rate
Number of Bootstrap Replications	2000	2000
Trimming Percentage	0.15	0.15
Threshold Estimate	393.02	10.84
Bootstrap P-Value	1	1

Second, our threshold test result for the tariff rate indicates that the effects of tariff level on non-tariff barriers do not differ between high and low tariff situations. This result implies that SPS notifications are determined from a political perspective rather than an economic perspective. Less competitive industries have a higher chance to be sacrificed by a tariff reduction compared to more competitive industries, due to import competition. With an economic view, each government has a different level of non-tariff barriers depending on the tariff reductions by industry. However, our result shows that each government sets the same increasing rate in non-tariff barriers to deal with a tariff reduction. This implies that the government's choice for non-tariff barriers is determined by politics rather than economics.

Table 3.4 The Results of Three Models of SPS Notifications

	Panel Fixed Effect Model	PPML Model	Fixed Effect Tobit Model
Ln(Tariff Rate)	0.031 (0.0826)	-0.121 (0.1033)	0.122 (0.1314)
Ln(GDP per capita)	0.999*** (0.1836)	1.602*** (0.2690)	1.553*** (0.3133)
Ln(Unemployment Rate)	0.0274 (0.1554)	-0.493 (0.6529)	0.107 (0.2147)
Ln(Exchange Rate)	0.524*** (0.1673)	0.796** (0.3768)	0.957*** (0.2787)
Ln(Relative Size)	0.626*** (0.2390)	0.830** (0.3357)	0.855** (0.4220)
Constant	-9.017*** (1.6090)	-16.184** (2.8273)	670.491 (400697.2)
Log Likelihood	-	-2679.92	-769.26
R-square	0.692	0.526	-
Observations	790	665	790
Censored Observations	-	-	378
Dropped Observations	-	125	-

Note: ***, **, * Significant 1%, 5%, and 10%, respectively. () is standard error

The estimation result for tariff barrier effects on SPS notifications in the agricultural sector are presented in Table 3.4. Results are presented for the Panel Fixed Effects model, PPML model, and Fixed Effects Tobit model. The Fixed Effects Tobit model shows that 378 observations are censored due to zeros in SPS notifications. The signs of coefficients of each independent variable are the same for all estimation techniques. Furthermore, the coefficients for each independent variable are similar in magnitude.

According to the Fixed Effects Tobit model, the log of tariff rate has no significant effect on the expected log of SPS notifications for the agricultural sector at the 10% significance level. This result does not match the expectations of political economists who argue that tariff and non-tariff barriers have a substitute relationship. Furthermore, this result also contradicts the law of constant protection espoused by Bhagwati (1989). There may exist two possible explanations for this result. First, other types of non-tariff barriers exist, such as Technical Barriers to Trade (TBT), in agricultural sectors. This study uses SPS notifications to measure non-tariff barriers in agricultural sectors; however, SPS notifications do not represent all non-tariff barriers in agricultural industries. Thus, this analysis might miss the hypothesized relationship between tariff and non-tariff barriers from political economists and Bhagwati (1989). Second, this result may be explained by special characteristics of the agricultural sector. The agricultural industry has different non-tariff barriers compared to the manufacturing industry. For example, a minimum market-access agreement was in place for the Korean rice market until 2014. Under this circumstance, the government does not have an incentive to increase SPS regulations to deal with the reduction of tariff barriers since the Korea rice market already is protected through minimum market access provisions.

The log of GDP per capita has a positive effect on the expected log of SPS notifications in agricultural sectors for all three models, as expected. GDP per capita has a positive effect on SPS notifications because high-income people are more sensitive to food safety issues compared to low income people. This result suggests that NTBs in agricultural sectors are likely related to food safety issues and the demand for safer food.

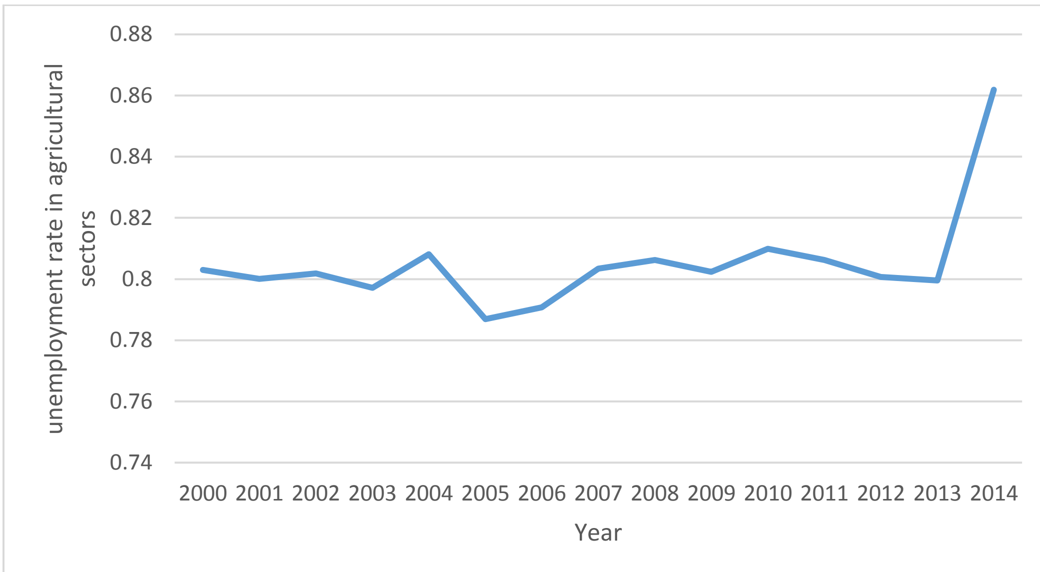

Figure 3.2 The Unemployment Rate in Agricultural Sectors (World Average)

Source: Author's calculation based on the World Bank Database

This paper has two societal variables, the log of the unemployment rate and exchange rate. The log of unemployment rate does not have a significant effect on SPS notifications. This result is not matched with the societal approach and the study of Mansfield and Busch (1995). It might be explained by the characteristics for agricultural industries. First, agricultural sectors have small variations in the unemployment rate, shown in the figure 3.2. Thus, the unemployment effect on SPS notifications may be limited. Second, agricultural employment is small and has a decreasing trend (Figure 3.3). Thus, employment in agriculture might not be important enough to warrant NTBs.

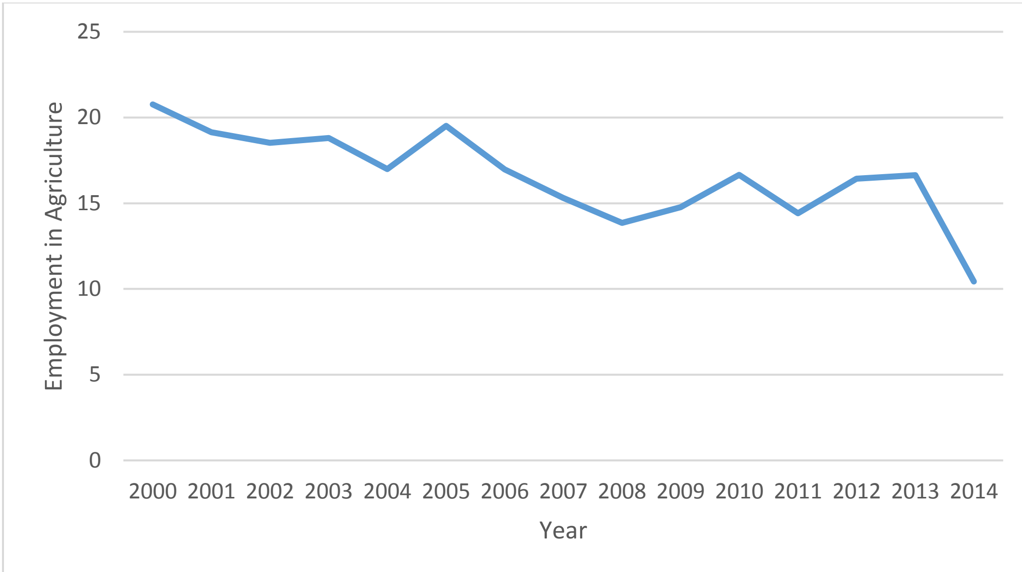

Figure 3.3 The Employment in Agriculture

Source: WTO database

The log of exchange rate has a positive effect on SPS notifications. This result supports the societal approach since appreciated currencies are highly connected to the occurrence of SPS notifications. This result is also supported by Mansfield and Busch (1995) since their result shows a positive and statistically significant effect of exchange rate on non-tariff barriers. According to their argument, exports and import-competing industries are endangered by an appreciated currency. Thus, there is a need to protect the threatened industries.

This paper also includes the relative size of the agricultural sector, for the statist approach. The log of relative size of agricultural industries has a positive effect on SPS notifications. This result supports the statist approaches and is supported by Mansfield and Busch (1995).This result indicates that a country with higher GDP in the agricultural sector has more political power to push politicians compared to a country with lower GDP in the agricultural sector. This result also shows that even if an industry's GDP is small, it will have a power to push politicians.

3.8. Conclusions

This paper investigates the political determinants of SPS notifications using a fixed effect Tobit model. Furthermore, this paper tests threshold nonlinearity with respect to GDP per capita and tariff rate. The threshold non-linear test results show that we cannot reject the null hypothesis of a linear relationship. This result provides two insights. First, food safety demand does not differ according to a country's income (no threshold relationship based on GDP per capita), thus there is a need to focus on a quality competition in terms of food safety among all countries. Food safety concerns will continue to heighten and influence SPS notifications as all countries develop. Firms need to find ways for enhancing agricultural products' quality based on food safety. One way to enhance the quality in agricultural sectors might be by using private party certification. Private certifications for agricultural products quality are usually stricter than governments food safety standards (Caswell and Johnson, 1991; Henson and Reardon, 2005).

Second, there is no difference in the effect of tariff rate on SPS notifications by tariff level. This result shows that a political view better explains the determination of SPS notifications compared to an economic view. Based on an economic view, a government needs to set higher non-tariff barriers in less competitive industries compared to industries that are more competitive. When trade liberalization increases competition for less competitive industries, these industries suffer more. However, our result indicates that the tariff reduction effect on SPS notifications is not different between high and low competitive industries. This implies that stakeholders in the weak industry need to present their voice more compared to stakeholders in the competitive industry, since the probability of sacrificing of weak industry is higher than the competitive industry.

Our results show that there is no significant relationship between the tariff and SPS notifications. This result contradicts the law of constant protection. Three possible explanations exist for our results. First, SPS regulations are just one type of non-tariff barriers. There may be several other non-tariff barriers, but they are difficult to measure empirically. Second, agricultural sectors have different characteristics compared to manufacturing sectors since they depend more heavily on non-tariff barriers rather than tariff barriers. Third, trade conflicts or WTO penalties, which can come from increasing non-tariff barriers, constrain governments from setting higher non-tariff barriers.

The results of this paper indicate that statist approaches explain the determinants for SPS notifications well, since the relative size of agricultural sectors has a positive effect on SPS notifications. The results also indicate that societal approaches do not well explain the determinants for SPS notifications because the unemployment rate in agricultural sectors does not have a significant effect on SPS notifications. In other words, politicians make trade policy based on pressure groups rather than national interests. These results have implications for governments and stakeholders. First, governments can have a better strategy during trade negotiations with other countries based on our results. Governments should pursue their countries' benefit from trade negotiation by focusing on industries in foreign countries that have no pressure groups and lower competitiveness. Second, stakeholders in industries with incompetent pressure groups have to realize that they are likely to face more stringent competition from imports, because governments will not protect them. Thus, they need to organize their interest groups for protecting their own interests.

GDP per capita has a positive effect on SPS notifications, which suggests that food safety demand explains variations in SPS notifications. This result indicates that high income people are more sensitive to food safety problems compared to low income people since SPS notifications are related with food safety.

The results of this paper have some limiting factors. First is the dataset itself. This paper uses aggregated data for the agricultural sector, however, if we can get more detailed data, we could have a more detailed analysis to capture the specific characteristics of agricultural sectors which have an effect on SPS notifications. Second is this paper does not consider all non-tariff barriers. Thus, there is a need to find some way to consolidate other non-tariff barriers, such as TBT or quota, since SPS notifications is just one of non-tariff barriers in agricultural sectors.

Even though this paper has some limitations, our contribution is clear. First, this paper questions the linearity assumption for non-tariff barrier determination. Using a threshold nonlinearity specification, we test for nonlinearity in SPS notifications based on GDP per capita and tariff level and find it to be a linear relationship. Furthermore, we derive implications for quality competition based on our threshold test results. Second, this paper finds that food safety concerns are related non-tariff barriers such that SPS notifications are connected with food safety demand as well as tariff reductions. Lastly, this study provides the basic logic to governments for negotiating trade barrier reductions.

Chapter Four

The Impact of Trade Barriers on Skilled and Unskilled Employment of Food Manufacture Firms in Developing Countries

4.1 Introduction

Unemployment imposes costs to individuals as well as countries. To the individual, a lost job means deterioration in living standards because of reduction of income and job searching costs, likely leading to reduced consumption. To the country, unemployment leads to lower gross domestic product (GDP) and higher government costs related to state and federal governments providing unemployment benefits and other income supports. Furthermore, sustained unemployment can lead to increased social problems such as suicide, depression, and other illnesses (Andrés, 2005). For these reasons, there is a need to keep the unemployment rate at an appropriate low level. However, the world unemployment rate has fluctuated steadily since 1991 (Figure 4.1), and figuring out factors that lead to unemployment fluctuation has important policy implications.

Large parts of recent fluctuation in unemployment can be explained by a rapid globalization trend that implies a reduction of trade barriers. Technological innovation has spread more quickly over time due to increased flow of information and trade openness. Many papers show that technology is transferred through trade in intermediate goods (Coe and Helpman, 1995; Keller, 2001; Keller, 2002). Frankel and Rose (2002) suggest that international trade leads to productivity growth through increases in technology. Furthermore, trade liberalization leads to increased competition, so that each firm has more incentive to adopt new technologies and machinery. The technology innovation that is caused by a reduction of trade barriers leads to a decrease of employment if the innovation is based on labor-reducing technologies (Koellinger, 2008).

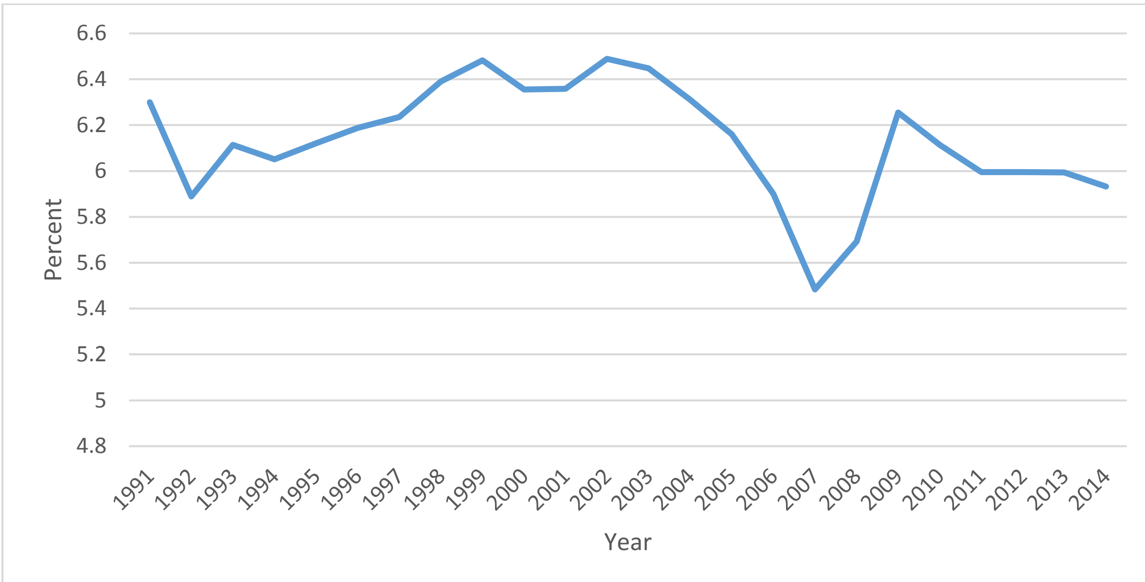

Figure 4.1 World Unemployment Rate

Source: World Bank

Trade liberalization also encourages countries to specialize in specific sectors or industries where they have a comparative advantage based on the Hecksher-Ohlin theory. This specialization allows each country to enjoy scale economies as resources shift from sectors with high relative costs to sectors with low relative costs. Trade liberalization creates jobs in some sectors and destroys jobs in others, forcing labor to move across industries in accordance with each country's comparative advantage. This labor reallocation creates unemployment in one sector and employment in the other. The more friction there is in labor movements, the more unemployment will exist. Considering the worldwide trend in trade liberalization there is a need to focus on unemployment resulting from trade effects.

Figure 4.2 Numbers of Non-tariff Measures (2005-2016)

Source: WTO Database (http://i-tip.wto.org/goods/Forms/GraphView.aspx?period=y&scale=ln)

Previous empirical literature for trade and employment focus on industry or country levels rather than firm level. Even though some studies such as Haltiwanger et al. (2013) and Centeno et al. (2007) investigate the relationship between trade barriers and employment at the firm level, they do not use an econometric model for their firm-level analysis so they do not to find the determinants of employment in a rigorous statistical sense. Furthermore, previous studies focus on tariff barriers rather than non-tariff barriers.

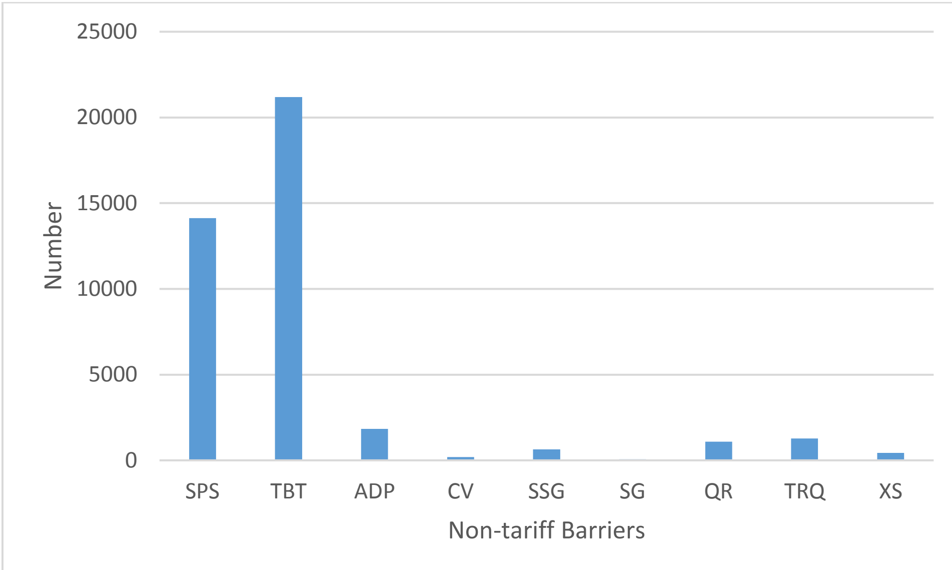

Figure 4.3 World Non-tariff Barrier Claims to WTO (date: 6/60/2016; initiated and in force)

Source: World Trade Organization

Note: Anti-dumping [ADP], Countervailing [CV], Quantitative Restrictions [QR], Safeguards [SG], Sanitary and Phytosanitary [SPS] [Regular, Emergency], Special Safeguards [SSG], Technical Barriers to Trade [TBT] [Regular], Tariff-rate quotas [TRQ], Export Subsidies [XS]

This paper focuses on a firm-level analysis of the relationship between trade and unemployment. Furthermore, in this study, trade liberalization measures include both tariff and non-tariff barriers. Tariff barriers have decreased steadily through WTO negotiations, bilateral trade agreements, and multilateral agreements. On the other hand, non-tariff barriers do not show a decreasing trend (Figure 4.2). As a result, the importance of non-tariff barriers has increased compared to tariff barriers, especially for the food and agriculture sector. Our analysis focuses on the effects of trade policy on unemployment, especially involving non-tariff barriers. According to WTO specification, Technical Barriers to Trade (TBT) and Sanitary and Photosanitary (SPS) barriers are representative of non-tariff barriers (Figure 4.3). TBTs are applicable to all industries, but SPS barriers are only applicable to the agri-food sector because SPS relates to food safety.[15] Since food safety relates directly to human health, agri-food industries have different regulations compared to other industries. This paper focuses on non-tariff barriers related to food safety of food industries.

Utilizing a structural equation model and data for food manufacturing firms in developing countries registered on the World Bank Enterprise Survey, this paper investigates the impact of trade barriers on employment. This paper also divides the employment in the food manufacturing industries into skilled and unskilled labor. The production process within the food industry mainly requires low-skills (Fuller, 2001), so unskilled workers are mainly used for food products. Thus, this paper assumes that the trade liberalization effect on employment in the food industry is largely based on unskilled rather than skilled workers. This paper contributes to the empirical work on the relationship between trade and unemployment in several ways. First, this paper considers trade liberalization effects at the firm level rather than the country or industry level. Firm level analysis provides more detailed information compared to the country or industry level analysis because it contains firm level characteristics that are absent at other levels. For example, if exporting firms create more jobs than non-exporting firms do, then government funds may need to concentrate on helping exporting firms. One way to support exporting firms is through export incentives such as interest rates, taxes, or legal

[15] According to Aisbett and Pearson (2012), the objective of SPS is protecting human, plant, and animal health.

incentives. Second, this study divides employment into skilled and unskilled workers since the production within the food industry does not require high skills. Thus, we can provide policy implications to government based on which types of workers in food manufacturing are more affected by trade liberalization.

4.2 Theoretical Background for Employment

There are several theoretical models for the determination of employment. The neoclassical theory of labor markets explains the determination of wage and employment primarily through the supply side of the economy (Abdalla et al., 2010). It focuses on workers' choices between labor and leisure, ignoring labor demand. Human capital theory tries to explain employment and wages through public and private investments in education or skills training (Becker, 2009). Higher skills indicate higher marginal productivity, which leads to higher income. Moreover, higher skills with a higher marginal productivity attracts employers to hire higher-skilled workers compared to lower skilled workers. However, these theoretical models do not explain the employment fluctuation since they have the implicit assumption of no voluntary unemployment.

On the other hand, the Keynesian theory of employment explains fluctuations in employment well. This theory assumes that employment is determined by the firms' output, given the technology (Gali, 2013).[16] In other words, macroeconomic variations explain variations in employment through macroeconomic effects on firms' outputs. For example, Black (1982), Lilien (1982) and Davis (1987) find that the business cycle has an impact on labor allocation among industries, which brings about unemployment to

[16] A firm's output is a function of aggregate demand for goods (Gali, 2013)

specific industries. Paul and Siegel (2001) find that technology has a large effect on changes in labor composition between skilled and unskilled labor. Doğrul and Soytas (2010) also argue that macroeconomic variables such as business cycle and technology level have a large role in explaining the level of unemployment.

For these reasons, some literature focuses on the relationship between trade and unemployment (Helpman and Itskhoki, 2010). The main two theoretical approaches to explaining comparative advantage, the Ricardian and Heckscher-Ohlin approaches have differing results relative to trade liberalization and unemployment. The Ricardian model, based on comparative advantage, shows that trade liberalization leads to decreases in unemployment (Dutt et al., 2009).[17] On the other hand, the Hecksher-Ohlin model shows that only labor abundant countries can reduce unemployment through trade liberalization (Dutt et al., 2009). The theoretical literature on the relationship between trade and unemployment is relatively small, though the theoretical literature is larger than the empirical literature (Hasan et al., 2012).

4.3 Empirical Literature for Trade and Employment

There are few empirical literatures for the relationship between trade and unemployment. Greenaway et al. (1999) investigate the impact of trade on employment of 167 manufacturing industries in United Kingdom utilizing panel data from 1979 to 1991. They find that an increased volume of exports and imports has a negative effect on

[17] Dutt, et al. (2009) argue that trade liberalization leads to a change in the relative price between two goods (X and Y). If the price of X increases and the price of Y decreases, then the profitability of good X will increase. In this case, wages in X increase and employers have an incentive to move from Y to X. At the same time, capital moves to X, which allows improved productivity in X. In the end, jobs producing X increase and jobs producing Y decrease. The increased number of jobs producing X is larger than the decreased number of jobs producing Y (Dutt et al., 2009).

derived labor demand. Attanasio et al. (2004) show that a tariff rate has a small positive effect on share of industry employment utilizing the data from Columbia. The results of Porto (2008) represent that 10% increase of export price triggers an increase of employment probability by 1.36 percentage points. Menezes-Filho and Muendler (2011) examine the Brazil's trade liberalization effect in the 1990s on employment. They present the result that tariff reduction leads worker displacements even if workers in industries with comparative advantage. To sum up, most empirical studies for trade liberalization and employment focus on state or industry level rather than firm level. However, it is likely that individual firms in the same state or industry have a different relationship between trade and unemployment.

Most studies on determinants of firm level unemployment (employment) focus on firm characteristics rather than on trade liberalization effects on unemployment (employment). For example, Haltiwanger et al. (2013) includes determinants of firm-level job creation and destruction, such as firm size, firm age, and firm birth. Firm size as a factor in job creation is supported by Gibrat's law, which represents an inverse relationship between firm size and growth (Sutton, 1997). Firm age and births may have an inverse relationship with the employment rate since Centeno et al. (2007) find that average firm age has an inverse relationship with job creation. These firm-level studies find the determinants of unemployment (employment) by comparing firm characteristics and employment trends. These previous studies do not consider firm-level trade policy effects on employment.

4.4 Model Development

This paper follows the empirical model suggested by Greenaway et al. (1999). They assume a Cobb-Douglas production function with the representative firm:

$$Q_{itj} = A^{\gamma} K_{itj}^{\alpha} L_{itj}^{\beta} \tag{1}$$

where country *i*, year *t*, firm *j*, and *Q* is output, *A* is technology, *K* is capital, *L* is unit of labor used by a firm, and coefficients (α and β) indicate shares for each factor and γ indicates the technology for the production process.

The conditions for profit maximization, i.e., Marginal Revenue of Labor = Wage (w) and Marginal Revenue of Capital = Interest Rate (r), allow us to obtain equation (2) from equation (1):

$$Q_{itj} = A^{\gamma} (\frac{\alpha L_{itj}}{\beta} \cdot \frac{w_{it}}{r_{it}})^{\alpha} L_{itj}^{\beta} \tag{2}$$

Taking logarithms of both sides of equation (2) and rearranging the terms according to labor demand (L).

$$L_{ij} = \phi_0 + \phi_1 \ln\left(\frac{w_{it}}{r_{it}}\right) + \phi_2 lnQ_{itj} \tag{3}$$

where $\phi_0 = -(\gamma lnA + \alpha ln\alpha - \alpha ln\beta)/(\alpha + \beta)$, $\phi_1 = -\frac{\alpha}{\alpha+\beta}$, and $\phi_2 = 1/(\alpha + \beta)$.

Badinger (2008) summarizes several ways that greater international trade can affect productivity. The first channel is increasing returns to scales from enjoying a larger market by trade (Balassa, 2013). The second way is the spillover effect from experiencing the foreign market (Feder, 1983). The last channel is the international transmission of technology (Coe and Helpman, 1995). Productivity is a proxy variable for a technology, which means that trade has an effect on technology growth. Thus, Greenaway et al. (1999) suggests that A (technology) can be specified as a function of factors that influence trade. We modify their equation to obtain the following function:

$$A_{itj} = e^{\delta_0 C_i} T_{it}^{\delta_1} S_{it}^{\delta_2} \tag{4}$$

where C is the country effect, T is the tariff rate, and S is SPS.

Using equations (3) and (4), we derive the following equation: [18]

$$\ln L_{itj} = \phi_0^* + \mu_0 C - \mu_1 lnT_{it} - \mu_2 lnS_{it} + \phi_1 \ln\left(\frac{w_{it}}{r_{it}}\right) + \phi_2 lnQ_{itj} \tag{5}$$

where $\phi_0^* = -\frac{\alpha ln\alpha - \alpha ln\beta}{\alpha+\beta}, \mu_0 = \mu\delta_0, \mu_1 = \mu\delta_1, \mu_2 = \mu\delta_2, and\ \mu = \gamma/(\alpha+\beta)$

4.5 The Empirical Model and Estimation Method

This paper adopts a structural equation model (SEM) to estimate the effects of trade liberalization on employment due to several econometric advantages. First, SEM allows one to estimate skilled and unskilled labor employment at the same time. This is possible because the SEM analyzes multivariate data with linear relationships among variables (Savalei and Bentler, 2010), and the SEM is considered as a mixture of factor

[18] Firm characteristics are added as control variables in this paper.

and path analysis (Hox and Bechger, 1998).[19] Second, considering the possible covariance between errors of skilled and unskilled employment, SEM allows one to overcome the endogeneity problem. Third, SEM can treat variables as exogenous and endogenous at the same time by estimating multiple equations simultaneously (McCoach et al., 2007). Furthermore, the generalized SEM (GSEM) takes into account hierarchical data characteristics.[20] The dataset for this study also has a hierarchy of upper and lower levels (2-dimensions). The upper level is the country level and the lower level is the firm level.

Using GSEM, this study models two different aspects that are not covered by the previous literature. First, employment is divided into skilled and unskilled where the food industry heavily depends on low-skilled workers. Second, possible covariance between the error terms in the equation for the skilled and unskilled labor functions is captured. Covariance between errors may exist since skilled and unskilled employment share unobserved effects. This possible covariance is shown in equation (6). Furthermore, a dummy variable for countries is added to the empirical model to capture possible heteroscedasticity across countries.[21] The model specification is shown in the following equations:[22]

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[19] Garson (2008) defines path analysis as "An extension of the regression model, used to test the fit of the correlation matrix against two or more casual models that are being compared by the researcher".

[20] Raudenbush and Bryk (2002) explain a hierarchical data structure as "Hierarchical in the following sense: We have variables describing individuals, but the individuals also are grouped into larger units, each unit consisting of a number of individuals".

[21] Data on the wage and interest rate are limited. The wage and interest rate for each firm may be similar for all firms within a country; thus, the country fixed effect may capture the $\frac{w}{r}$ term.

[22] Skilled and unskilled employment equations are from equation (5). To capture the indirect effect of trade barriers, the production equation is contained in GSEM. The covariance term is also contained in GSEM to capture possible correlation between ε_{1itj} and ε_{2itj}.

$$\ln(\text{Skilled\_}L)_{itj} = \beta_{01} + \beta_{11} lnT_{it} + \beta_{21} lnS_{it} + \beta_{31} lnQ_{itj} + X'\alpha + a_i + \varepsilon_{1itj}$$

$$\ln(Unskilled\_L)_{itj} = \beta_{02} + \beta_{12} lnT_{it} + \beta_{22} lnS_{it} + \beta_{32} lnQ_{itj} + X'\alpha + a_i + \varepsilon_{2itj} \quad (6)$$

$$\text{Cov}(\varepsilon_{1itj}, \varepsilon_{2itj}) = \rho_1 \rho_2$$

where, *i* is a country, *t* is a year, *j* is a firm, *Total_L* is total employment, *Skilled_L* is skilled employment, *Unskilled_L* is unskilled employment, *T* is a tariff rate, *S* is SPS, *Q* is production quantity, *X* is a vector of firm characteristics, and ε and δ are error terms.

For a robustness check, this paper estimates three different models. The first model is the generalized structural equation model without the covariance term. The second model is the generalized structural equation model without the production function. The third model has three separate regressions. Table 4.1 summarizes the three models.

Table 4.1 Alternative Models for a Robustness Check

Model	**Description**	**Equation**
Model 1	Without Covariance	$\ln(\text{Skilled\_}L)_{itj} = \beta_{01} + \beta_{11} lnT_{it} + \beta_{21} lnS_{it} + \beta_{31} lnQ_{itj} + X'\alpha + a_i + \varepsilon_{1itj}$ $\ln(Unskilled\_L)_{itj} = \beta_{02} + \beta_{12} lnT_{it} + \beta_{22} lnS_{it} + \beta_{32} lnQ_{itj} + X'\alpha + a_i + \varepsilon_{2itj}$
Model 2	With Covariance	$\ln(\text{Skilled\_}L)_{itj} = \beta_{01} + \beta_{11} lnT_{it} + \beta_{21} lnS_{it} + \beta_{31} lnQ_{itj} + X'\alpha + a_i + \varepsilon_{1itj}$ $\ln(Unskilled\_L)_{itj} = \beta_{02} + \beta_{12} lnT_{it} + \beta_{22} lnS_{it} + \beta_{32} lnQ_{itj} + X'\alpha + a_i + \varepsilon_{2itj}$ $\text{Cov}(\varepsilon_{1itj}, \varepsilon_{2itj}) = \rho_1 \rho_2$
Model 3	Separate Regressions	$\ln(\text{Skilled\_}L)_{itj} = \beta_{01} + \beta_{11} lnT_{it} + \beta_{21} lnS_{it} + \beta_{31} lnQ_{itj} + X'\alpha + a_i + \varepsilon_{1itj}$ $\ln(Unskilled\_L)_{itj} = \beta_{02} + \beta_{12} lnT_{it} + \beta_{22} lnS_{it} + \beta_{32} lnQ_{itj} + X'\alpha + a_i + \varepsilon_{2itj}$

4.6. Data Description

This paper uses the World Bank Enterprise Survey data to estimate the effects of reduced trade barriers on firm level employment. The World Bank Enterprise Survey data consists of firm characteristics and the firm's environment such as regulations, taxes, corruption, crime, informality, gender, finance, infrastructure, innovation, technology, trade, workforce, firm characteristics, and performance. Among these data, this paper uses skilled employment, unskilled employment, production sales (proxy for quantity), and firm characteristics (firm age, firm size, exporting or not) from 2006 to 2014.[23]

Table 4.2 Descriptive Summary Statistics (N=1,673)

Variable	Type	Description	Mean	Std. Dev.	Exp. Sign
ln_skilled_worker	continuous	Number of skilled production worker	2.650	1.556	
ln_unskilled_worker	continuous	Number of unskilled production worker	2.766	1.564	
ln_tariff	continuous	Weighted average tariff rate	2.824	0.672	-
ln_sps	continuous	Number of SPS notifications	2.156	1.406	-
ln_quantity	continuous	Real annual sales growth (%)	2.380	1.166	+
ln_age	continuous	Number of firm age	2.914	0.807	+
size	binary	1 if the firm size is large; 0 otherwise	0.305	0.461	+
exporter	binary	1 if the firm export; 0 otherwise	0.213	0.409	+

[23] After managing the data, the maximum period for analysis is 2006 to 2014. The World Bank Enterprise Survey is performed periodically in each country, thus the dataset of this paper is an unbalanced panel. Developing countries are defined as those with an income lower than $12,476 (World Bank definition).

Data on SPS notifications are collected from the WTO integrated trade intelligence portal. Data on the weighted average tariff rate are gathered from the trade analysis information system of the United Nations Conference on Trade and Development (UNCTAD). Our sample has 1,864 firm observations with 21 developing countries. Table 4.2 shows descriptive summary statistics with expected sign for all variables used in this analysis.

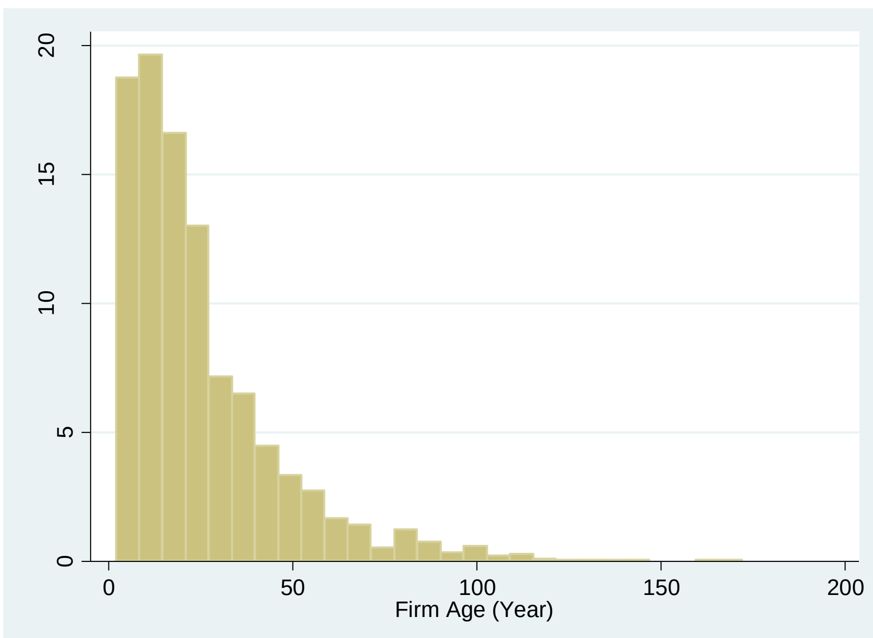

Figure 4.4 Histogram for Food Manufacturing Firm Age within the Dataset

Figure 4.4 shows the histogram for the age of food manufacturing firms within the dataset from 2006 to 2014. This histogram indicates that most firms are less than 30 years old. The two most frequent ages for firms are both less than 10 years of tenure. This phenomenon may represent two aspects. First, the food industry in developing countries may not be matured since developing countries are normally in the early stage of development. Second, food manufacturers in developing countries are small, and small firms close their businesses more often compared to large firms. Thus, the firm age of most food manufacturers in developing countries is young compared to developed countries such as the U.S. (Figure 4.5).

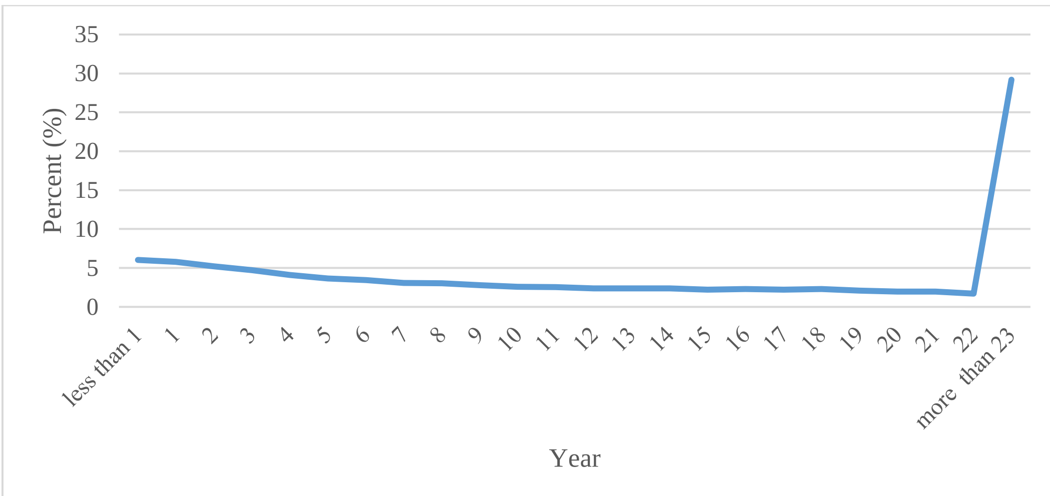

Figure 4.5 Firm Age Share of Agriculture, Forestry, Fishing, and Hunting in U.S. (2016)

Source: U.S. Bureau of Labor Statistics (https://www.bls.gov/bdm/us_age_naics_11_table5.txt)

Table 4.3 shows the skilled worker ratio of food manufacturing firms in developing countries. Most firms employ around 30% skilled workers and the average share for developing countries is 40%. Thus, food industry employment in developing countries is dominated by unskilled labor.

Table 4.3 Skilled Worker Ratio of Food Manufacturing Firms in Developing Countries

Country	Skilled Worker Ratio	Country	Skilled Worker Ratio
Argentina	0.30	Nicaragua	0.34
Bolivia	0.33	Peru	0.26
Brazil	0.37	Philippines	0.43
Chile	0.34	Russian Federation	0.48
Colombia	0.26	Sri Lanka	0.62
Ecuador	0.32	Turkey	0.42
Egypt, Arab Rep.	0.52	Uganda	0.37
El Salvador	0.25	Ukraine	0.51
Guatemala	0.36	Uruguay	0.31
Indonesia	0.61	Vietnam	0.38
Jordan	0.58	Total Average	0.40

4.7. Estimation Results

Table 4.4 shows the results of the structural equation model with the covariance term (main model), structural equation model without the covariance term (model 1), and three separate regression models (model 2). Results of these three model show that coefficients and their significance are similar for all models. Furthermore, the covariance between the error of unskilled worker equation and skilled worker equation is positive and significant at the 1% significant level. Thus, capturing the covariance between errors is important in deriving unbiased estimators.

Table 4.4 Results from the Estimation of Models

Dependent Variable	Independent Variable	Main Model		Model 1		Model 2	
ln_skilled	ln_quantity	-0.0029		-0.0029		-0.0030	
		(0.02335)		(0.02335)		(0.02354)	
	ln_tariff	-0.1408		-0.1408		-0.1408	
		(0.29906)		(0.29906)		(0.30150)	
	ln_sps	0.0291		0.0291		0.0292	
		(0.09109)		(0.09109)		(0.09184)	
	ln_age	0.1284	***	0.1284	***	0.1284	***
		(0.03516)		(0.03516)		(0.03544)	
	size	2.1969	***	2.1969	***	2.1969	***
		(0.06172)		(0.06172)		(0.06222)	
	exporter	0.3340	***	0.3340	***	0.3340	***
		(0.06982)		(0.06982)		(0.07039)	
	Intercept	1.7421	*	1.7421	*	1.7421	*
		(1.0147)		(1.0147)		(1.02296)	
ln_unskilled	ln_quantity	0.0304		0.0271		0.0272	
		(0.02862)		(0.02922)		(0.02959)	
	ln_tariff	-0.9061	***	-0.8415	**	-0.8415	**
		(0.02862)		(0.35100)		(0.35548)	
	ln_sps	-0.3052	***	-0.2758	**	-0.2758	**
		(0.10659)		(0.10847)		(0.10985)	
	ln_age	0.4301		0.0364		0.0364	
		(0.04117)		(0.04190)		(0.04244)	
	size	2.2319	***	2.2148	***	2.2149	***
		(0.07046)		(0.07158)		(0.07249)	
	exporter	0.3757	***	0.3475	***	0.3479	***
		(0.07878)		(0.07994)		(0.08096)	
	Intercept	5.0395	***	4.8236	***	4.8236	***
		(1.17950)		(1.1999)		(1.21523)	
e.ln_skilled		1.122		1.122		-	
		(0.0388)		(0.0388)		-	
e.ln_unskilled		1.0633		1.0682		-	
		(0.0456)		(0.0460)		-	
Cov (e.ln_unskilled,e.ln_skilled)		0.3326	***	-		-	
		(0.0330)		-		-	
Observations		1,673		1,673		1,673	
Log likelihood		-3,980		-4,035		-	
R-square for ln_skilled		-		-		0.54	
R-square for ln_unskilled		-		-		0.56	

Note: ***, **, * Significant 1%, 5%, and 10%, respectively. () is standard error

Discussion focuses on the Hecksher-Ohlin theory with the results of structural equation model with the covariance term between errors of skilled and unskilled workers (the main model). Tariff and SPS notifications do not have a significant effect on skilled labor employment from technological change by food manufacturers. This result supports the Hecksher-Ohlin theory since skilled laborers are not abundant in developing countries compared to developed countries.[24] Fuller (2001) argues that the food industry heavily depends on low-skilled workers for the production process.

Firm characteristics, such as firm size and being an exporter, have a positive effect on unskilled employment of food manufacturers, as expected. However, firm age does not have a significant effect on unskilled employment, which contrasts with the result for skilled labor. This result indicates that the process of firm aging in the food industry of developing countries requires high skilled labor rather than low skilled labor. That might be related with the age structure of food firms in developing countries (Figure 4.4). The ratio of firms aged over 10 years is low, which means that the survival rate of food firms in developing countries is lower over time. In other words, only a few food firms in developing countries survive 10 years after their formation, which means that few firms change their production structure from low-skill to high-skill labor technology.

[24] According to the Hecksher-Ohlin theory based on comparative advantage, high-skilled labour scarce economies, such as developing countries, cannot increase high-skilled employment by trade liberalization of tariff or non-tariff barriers.

4.8 Conclusions

This paper investigates the effect of trade barriers on skilled and unskilled employment of food manufacturers in developing countries. This study captures the differential impacts of tariff versus non-tariff trade barriers on employment in food manufacturing. The results of this paper show that a reduction of trade barriers has a positive effect on low-skilled employment by food manufacturers. Tariff barriers have a larger effect on low-skilled employment by food manufacturers compared to nontariff barriers (SPS notifications). On the other hand, trade barriers do not have a significant effect on skilled employment.

The results of this paper provide some policy implications for governments and firms. First, governments of developing countries may need to support food firms through other policies when they reduce non-tariff barriers. Our results show that a reduction of SPS has a negative effect on food firm production in developing countries. Furthermore, governments should focus their negotiation strategies on tariff reductions in the food industry since a tariff reduction does not cause decreased production.

Second, governments of developing countries need to promote the trade of food manufacturing goods since a reduction of trade barriers has a positive effect on unskilled employment in food manufacturers. Considering that the food industry is mainly protected by non-tariff barriers being related to food safety (in terms of microbiology and toxicology) and quality (in terms of appearance and taste) (Fryer and Versteeg, 2008), new technology focusing on food safety and quality would overcome the trade barriers for food safety. One example is supporting food firms to obtain private or third party certifications such as GlobalGAP and SQF.[25] Private and third party certifications need more technology since this type of certification requires higher food safety levels compared to government standards. Furthermore, adapting to private or third party certifications is helpful for developing countries to reach export markets (Kleemann et al., 2014). Thus, supporting firms for third party certifications may help increase employment by increased exports.

Third, firms need to plan for their future employment based on their internal and external environment. The internal environment represents firm characteristics such as firm age and firm size, and the external environment indicates surroundings of firms such as tariff and non-tariff barriers. The results of this paper show that firm age has a positive effect on skilled employment by food manufacturing firms. Based on this result, old firms need to focus on skilled labor rather than unskilled labor compared to young firms. The results of this paper indicate that a reduction in tariff and SPS barriers has a positive effect on unskilled employment of developing countries. Based on this result, the implementation of bilateral and multilateral trade agreements may increase unskilled employment in developing countries.

[25] Third party or private certifications is normally higher than government certifications in terms of quality and safety (Henson and Reardon, 2005).

Chapter Five

Summary and Conclusions

This dissertation investigates three issues of food safety regulations and international trade of agricultural products. Chapter 2 examines the impact of MRL on U.S. vegetable exports based on the specification of a gravity model. Our results show that a strict MRL of importing countries has a negative effect on vegetable imports, while a higher level of MRL in U.S. has a positive effect on U.S. vegetable exports. This implies that the government should evaluate strict food safety regulations based on three aspects: first is human health, second is a role of non-tariff barrier, and the last is the competitiveness of vegetable producers from the signalling effect. By utilizing the multilevel model with random income effect according to each countries, we find that the impact of MRL in U.S. on U.S. vegetable exports is not different between high and low-income countries. This implies that most countries have a common tendency to establish the strict food safety regulations for the human health regardless of each countries' income level.

Chapter 3 figures out the political determinants of non-tariff barriers that are associated with food safety by utilizing the threshold regression method. Based on the threshold non-linear test results, we find that there is no threshold with respect to GDP per capita and tariff rate. No threshold in GDP per capita implies that the income of country does not make difference in food safety demand. No threshold in tariff rate represents the dominance of a political view on an economic view. If governments select their non-tariff rates based on an economic view, then there might exist a threshold value in tariff rate. It is because a reduction of tariff rate on welfare is different to industries, which represents economic value for non-tariff barrier adjustment to tariff rate is different. We find that GDP per capita is positively associated with SPS notifications, implying the importance of quality competition in food sector. Our results also show that there is no significant relationship between tariff and SPS notifications, which implies that a law of constant protection, the inverse relationship between tariff and non-tariff barriers, is not satisfied in the food sector.

Chapter 4 examines the impact of tariff and non-tariff barriers on skilled and low-skilled employment in developing countries' food firms. Our results represent that a reduction of trade barriers (both tariff and non-tariff) is directly and positively associated with unskilled employment. However, trade barriers are not associated with skilled labor employment. These results imply that the Hecksher-Ohlin theory is well fitted to food firms in developing countries. The food industries require low-skilled workers rather than skilled workers and developing countries abundant in low-skilled labor; in turn, the trade openness is expected to increase the low-skilled employment in developing countries. Interestingly, age of firm is positively only related to skilled employment, which implies that aged food firms in developing countries tend to change their production process from labor intensive to machine or capital intensive production.

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